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TUBERCULOUS HILAR AND MEDIASTINAL ADENOPATHY IN ADULTS[1]

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IN pulmonary tuberculosis of adults, enlargement of the hilar or mediastinal glands is not usually demonstrable on roentgen examination. These glands may be involved, but the appearance of the parenchymal lesion is far more obvious and is frequently the only diagnostic consideration. In children, there is practically always associated glandular involvement. In adults, early involvement of the hilar and mediastinal nodes is difficult to detect because there is considerable variation of the size and contour, and in many borderline cases the presence of pathology can be established only by the clinical and physical findings, the subsequent clinical course, and comparative roentgen studies. The x-ray may be a valuable therapeutic adjunct, as well as a means of diagnosis. The presence of an active focus in the lungs subsequent to the demonstration of hilar and mediastinal node enlargement is practically certain indication of a concomitant tuberculous lymph node process. However, consideration must always be given to the possibility of a variety of pathologic processes complicating pulmonary tuberculosis. The entity of hilar and mediastinal tuberculosis in adults is sufficiently important to be discussed and emphasized as a possibility when there is slight or questionable enlargement in these regions, particularly in the presence of atypical clinical and physical findings. The condition may be more prevalent than has been generally recognized.

In the past six years, 65 cases of tuberculous adenopathy of the hilar and mediastinal regions in adults have been diagnosed at the Philadelphia General Hospital on the basis of follow-up studies. Of these cases, 32 represent combined roentgenographic and autopsy findings.

This type of tuberculosis is characterized by a hyperplastic reaction of the lymph nodes to the infecting organism. This results in the formation of large, firm glandular masses which can be readily visualized on roentgen examination. The enlarged glands may attain huge proportions before they eventually break down. On the other hand, caseation necrosis may occur early, with the attendant clinical appearance of a fulminating infectious disease. In some instances these lesions resemble a primary tuberculous infection, while other cases show additional scars of old primary tuberculous foci.

The glandular enlargements appear as sharply outlined, well circumscribed, semicircular or convex areas of density noted more often in the hilar regions on one or both sides. They may extend to the

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mediastinum along the trachea, encroaching on the lumen and occasionally producing actual displacement. As a rule, there is not sufficient pressure to produce bronchial obstruction or atelectasis. Small granular calcifications are occasionally noted in the homogeneous shadows and this appearance usually suggests a tuberculous origin, although the glandular enlargement may be due to other causes.

In hyperplastic glandular tuberculosis there is generally no evidence of parenchymal involvement of the lung until the later stages. When the glands are of the fibrocaseous variety there may be early minimal or extensive pulmonary infiltration. Some of the cases in the series observed showed clear lung-fields. This form of tuberculosis is most commonly found in Negroes between the ages of 16 and 40 years and actually resembles the childhood form of tuberculosis. The lymph nodes are enlarged and discrete, and there is little or no associated mediastinitis as described by Kornblum and Cooper (1). It is seen more often in Negroes, probably because many of them have never been infected in childhood and also because of the high degree of susceptibility of this race to tuberculosis. That this entity may become of greater importance in the future is indicated by the decreasing incidence of positive reactors to the tuberculin test as shown by studies of large groups of students (2, 3).

These hyperplastic glands may be present for years with few or no symptoms. Often the complaint is that the patient has not been feeling well. Moderately advanced lesions are usually characterized by chronic cough with little or no expectoration, low grade fever, chest pains often described as substernal and usually intermittent, lassitude, weakness, loss of weight, hoarseness, at times night sweats, and rarely hemoptysis. When there is no improvement following therapy, there is sooner or later evidence of dissemination of tuberculosis, with resulting involvement of the meninges, peritoneum, spleen, liver, and occasionally the skeletal system. In advanced cases, the lungs show miliary and occasionally fibro-ulcerative tuberculosis. Frequently there is an associated hyperplastic adenitis of the deep mediastinal, retroperitoneal, and mesenteric nodes, but the superficial glands are not often involved. In rare instances, tuberculous infections originating about the hilum and mediastinum may form cold abscesses which burrow downward and drain into the lumbar region. In only a few instances did the enlarged mediastinal or hilar glands attain sufficient size to compress the bronchi with secondary atelectasis, and thus simulate primary malignancy in this area (4, 5). In one instance autopsy revealed the cause of death to be pressure on the right lower lobe main artery, with resulting thrombosis and massive infarction of the lung.

In the early stages the physical findings are meager, and in many instances the illness remains obscure until roentgen examination is carried out. The sputum is usually negative and roentgen examination is, therefore, of prime importance. These glandular enlargements may be detected early. The involvement may be unilateral or bilateral. When both hilar areas exhibit enlarged glands, differentiation from lymphoblastomatous lesions and other neoplastic adenopathies becomes more difficult. In tuberculosis the glands are more sharply circumscribed and occupy the hilar regions primarily, with upward extension along the trachea and lateral borders of the mediastinum. The superficial glands are not enlarged. Granular calcification within the gland strongly suggests tuberculosis, and in the terminal stages the tuberculous infiltration of the lung is, of course, diagnostic.

In the past two years, three cases of Hodgkin's disease with associated glandular tuberculosis of the hilar and mediastinal nodes have been observed. It is practically impossible to diagnose such a lesion during life unless regional nodes develop and biopsy is done. Early diagnosis is of utmost importance. The therapeutic roentgen test has proved helpful.

Rapid response to roentgen therapy usually indicates a lymphoblastomatous type of lesion. Failure to respond to irradiation probably indicates a primary or secondary malignancy. In tuberculosis the response is slow. More radiation is required than for lymphoblastoma, but less than for primary or metastatic malignancy. The cannon-ball metastases from hypernephroma, sarcoma, and teratoid tumors often exhibit similar hilar adenopathies, but follow-up studies usually show typical nodular parenchymal metastases. Sarcoidosis may bear some resemblance to this type of tuberculosis, but the associated cutaneous and bony changes and the usual enlarged subcutaneous nodes, together with a negative tuberculin test, aid in differentiation. Lesions of the vascular system, tumors of the thyroid, thymus, leukemia, and other inflammatory lesions of the mediastinum must also be considered, but can be eliminated usually by careful clinical and further roentgen studies.

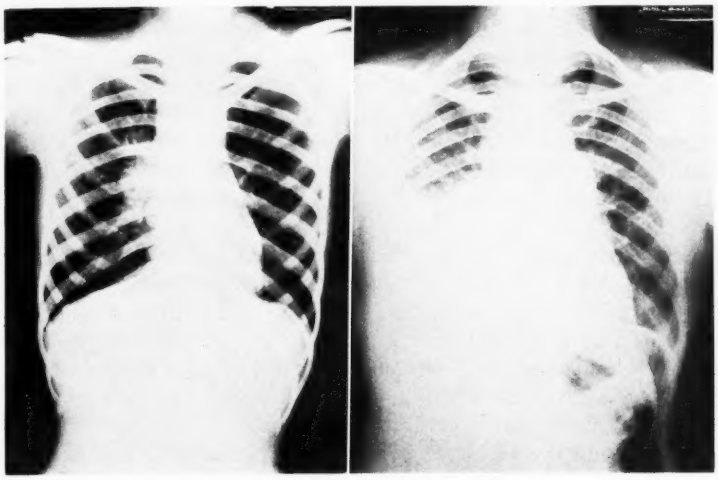

Fig. 1. Fig. 2.

Fig. 1. Case 1. M. E., female Negro, aged 19. Night sweats, cough, weight loss. Enlarged right hilar and mediastinal glands. Trachea displaced to left. Lungs clear.
Fig. 2. Case 2. S. H., female Negro, aged 49. Right chest pain, cough, weight loss. Glandular tuberculosis of right hilum and mediastinum. No pulmonary tuberculosis. Enlarged mediastinal and peribronchial glands by pressure on right lower lobe bronchus and pulmonary artery produced atelectasis, infarction, and pleurisy on right side.

The treatment of this type of tuberculosis involves essentially such hygienic measures as rest, adequate diet, and pleasant surroundings, which are indicated in the treatment of other forms of tuberculosis. Sanatorium treatment is usually warranted. Irradiation therapy has been tried in a few cases. Small doses, 75 to 100 r, using 200 kv. and 0.5 to 1 mm. Cu filter, given once or twice weekly for a total of five or six treatments, are apparently well tolerated. After a rest period of six to eight weeks, the series may be repeated if careful roentgen study of the involved area indicates persistent enlargement. There is no evidence of any untoward effects produced in these cases by radiation therapy, and the same uniformly good results obtained in the treatment of superficial tuberculous adenopathies may reasonably be expected. Treatment must, however, be instituted early because the adenitis frequently progresses and may be in the process of breaking down before treatment is given, so that the resultant complications may be

attributed to the irradiation. Pfahler (6) reports a case of this type of tuberculosis which responded well to roentgen therapy.

Illustrative case reports from the group of patients observed follow.

Case 1. M. E., Negress, aged 19, gave a history of not having been in the best of health during most of her life. She suffered frequent upper respiratory infections, but had never been bedridden. Six weeks before admission she "caught a cold" and began to cough. There was slight expectoration. Occasional fever was noted, and there had been a loss of 10 pounds in weight during the past two months. Marked emaciation was present. The temperature ranged from 98 to 100.6° F. The pulse was rapid. Positive clinical findings were limited to occasional transitory râles over the right upper lobe of the lung. The serology was negative, and blood urea and sugar were within normal limits. The sputum was negative for tubercle bacilli.

X-ray examination of the chest revealed enlarged nodular hilar shadows on the right side, with associated areas of well circumscribed convex density projecting laterally from either side of the upper mediastinum (Fig. 1). Reaction to the tuberculin test was strongly positive (P.P.D. first dilution).

The patient was placed on bed-rest, but failed to respond. Death occurred three months after admission. Autopsy revealed bilateral enlarged hilar and peribronchial tuberculous glands, with associated nodular caseous tuberculosis of the right upper lobe of the lung and tuberculosis of the peritoneum and spleen.

Case 2. S. H., Negress, aged 49, complained of poor general health. Ten months before admission she had first noticed early fatigue and exhaustion following light work. She contracted a "bad cold" at that time, from which she never quite recovered. There was noticeable loss of appetite and a loss of 12 pounds in weight. One week prior to admission, rather severe pain developed in the left chest. This became gradually worse, and on the day of admission she had a very painful attack, accompanied by severe coughing and hemoptysis of several cubic centimeters of bright red blood.

Physical examination of the chest revealed evidence of probable infiltration of the right upper lobe, with signs of thickened pleura and probable associated fluid at the right base. The temperature ranged from 99 to 103.4° F. There was a leukocytosis of 19,150, with 78 per cent neutrophiles. The sputum was negative for tubercle bacilli.

X-ray examination revealed a large circumscribed density projecting from the right mediastinum, and a similar large density projecting from the right hilar area. A rather homogeneous density was observed at the right base, suggesting a pleuritic process with associated fluid (Fig. 2).

The patient remained acutely ill and died twelve days after admission. Autopsy revealed the presence of huge mediastinal tuberculous glands of the hyperplastic type which produced pressure on the right lower lobe branch of the pulmonary artery, with thrombosis and massive infarction of the lobe. There was miliary tuberculosis of the spleen and liver, and healed tuberculosis of the mesenteric lymph nodes.

Case 3. C. R., Negress, aged 30, was admitted with the complaint of not having felt quite well for the past six months. For two weeks there had been moderately severe bilateral lower abdominal pain, with associated fever and chills.

Physical examination revealed marked bilateral lower abdominal tenderness and profuse yellowish vaginal discharge. Temperature was considerably elevated. A diagnosis of pelvic inflammatory disease was confirmed by positive vaginal smears.

After a week's rest in bed, the temperature became normal and an x-ray examination of the chest was ordered to rule out possible tuberculous infection suggested by apparent loss of weight and poor nutrition. The tuberculin test was strongly

positive. The sputum was repeatedly negative for tubercle bacilli. The x-ray of the chest (Fig. 3) revealed abnormal increased densities of a nodular type in both hilar areas, and similar dense shadows producing convex areas of density projecting laterally from either side of the upper mediastinum. There was no evidence of parenchymal infiltration. No superficial glandular enlargement was apparent.

Follow-up studies showed slow regression of the enlarged hilar glands, but the patient signed her release after two months in the hospital, and it has not been possible to contact her since that time.

Case 4. C. T., white female, aged 26, was admitted with the complaint of weakness and general malaise for the past three years. The symptoms had been more marked after each of two full-term pregnancies during that time. Substernal pain in the form of mild distress was first noted two years prior to admission. This became gradually more frequent and was very severe two weeks preceding admission. During the last week a dry cough had developed, and increasing hoarseness had been present for three days.

Clinical examination of the chest revealed nothing definite, and a provisional diagnosis of severe tracheobronchitis and laryngitis with possible early rheumatic fever or early tuberculosis was made. There was low grade fever ranging from 98 to 99.6° F. Moderate secondary anemia was evident, and the leukocytes totalled 10,700, with 65 per cent neutrophiles and 35 per cent lymphocytes. The tuberculin test was strongly positive. The sputum was negative for tubercle bacilli.

X-ray examination (Fig. 4) revealed definite increased densities of a nodular nature, bearing some granular calcifications in both hilar areas. These were more prominent on later examinations, but then gradually subsided. There was no evidence of parenchymal involvement. Definite improvement followed two months of bed-rest, and the patient was discharged in good condition.

Case 5. J. M., Negro male, aged 28, was admitted with a history of having felt well until the day of admission, when there was hemoptysis of a large quantity of bright red blood. There were no other complaints.

Clinical examination pointed to the

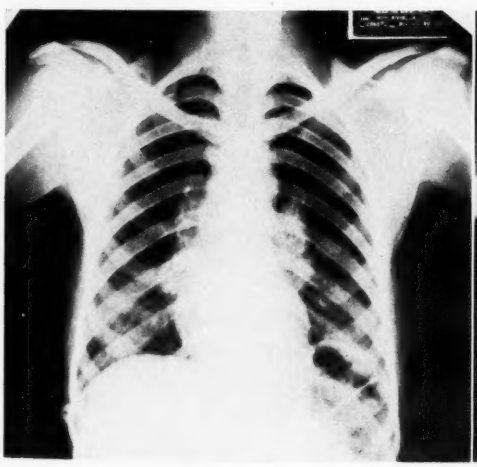

Fig. 3.

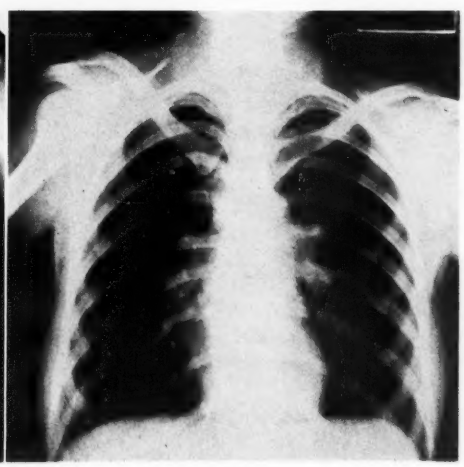

Fig. 4.

Fig. 3. Case 3. C. R., female Negro, aged 30. Dry cough and weight loss. Enlarged, sharply outlined bilateral hilar glands with no pulmonary or pleural involvement. Bilateral granular calcifications.
Fig. 4. Case 4. C. T., white female, aged 26. Bilateral hilar tuberculous adenitis. No pulmonary symptoms. Small calcified shadows in right hilum. No parenchymal involvement.

presence of a lesion in the right upper lobe. Laboratory data were non-contributory and repeated sputum examinations were negative until the eighth week after admission, when tubercle bacilli were found at one examination. The tuberculin test was strongly positive and blood serology tests were also positive. The temperature ranged between 99 and 100° F.

X-ray examination (Fig. 5) revealed evidence of enlarged hilar glands on the right side, with bilateral upper mediastinal adenopathy producing widening of the upper mediastinal shadow. There was evidence of probable beginning (minimal) tuberculous involvement of the right lower lobe. Subsequent examination revealed indubitable evidence of parenchymal tuberculosis involving the right upper and lower lobes, with persistence of the hilar and mediastinal adenopathy (Fig. 6). The patient remained in the hospital 18 weeks with little improvement. He refused sanatorium care and was discharged against advice.

It is believed that in this instance the hilar and mediastinal adenopathy had been present for some time before alarming hemoptysis occurred. Parenchymal involvement is a late manifestation in this form of tuberculosis and is frequently observed in cases that do not respond well to treatment.

Case 6. A. S., Negress, aged 24, gave a history of severe dry cough of 11 months' duration. There had been a loss of six pounds in weight. No hemoptysis had occurred. Three weeks before admission the cough had become more severe, with associated pain in the right upper chest. Occasional fever and chills had been noted two weeks prior to admission, and hoarseness had been present for three days.

Clinical examination of the chest was essentially negative, although tuberculosis was strongly suspected in view of the patient's history and general appearance. The temperature was normal. The sputum was negative for tubercle bacilli. Serology was negative. The tuberculin test was strongly positive.

X-ray examination of the chest revealed abnormal increased densities of the nodular type projecting from both hilar areas. These were well circumscribed, and similar nodular shadows extended from either side of the upper mediastinal shadow (Fig.

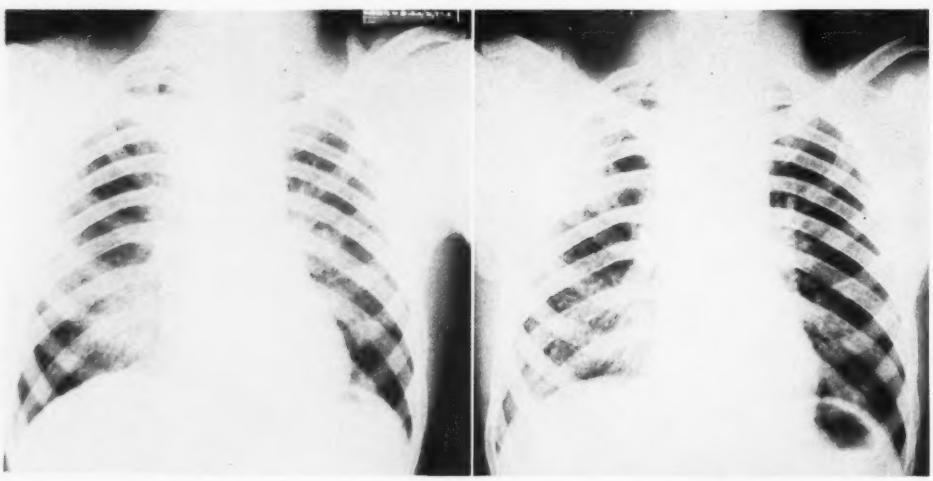

Fig. 5. Fig. 6.

Fig. 5. Case 5. J. M., Negro male, aged 28. Bilateral mediastinal adenopathy. Trachea narrowed in midline.

Fig. 6. Same case as shown in Figure 5, four and one-half months later. Mediastinal glands more sharply outlined. Tuberculous involvement of entire right lung.

7). There was evidence of probable early parenchymal involvement at the right base.

Examination four months later revealed increase in the extent of the glandular shadows on the right side. Definite tuberculous involvement of the right upper and lower lobes was now present, with associated effusion (Fig. 8). The patient improved steadily on bed-rest. Her weight increased from 120 to 144 pounds in six months, and she was discharged, much improved, to a sanatorium.

Case 7. L. J., Negress, aged 26, was admitted with a complaint of weakness during the past three months. Swelling of the abdomen had been present for two months, with vague abdominal pain, occasionally becoming rather severe. There had been a gradual loss of weight.

On examination, nothing definite was noted in the chest. The abdomen was distended, and there was diffuse mild tenderness with a feeling of doughiness on deep palpation. Dullness was noted in the flanks, with some associated bulging. The temperature ranged from 98 to 100° F. Serology was negative. The sputum was negative. A provisional diagnosis of tuberculous peritonitis was made.

Roentgen study revealed circumscribed dense convex shadows projecting from either side of the upper mediastinum, due to paratracheal adenopathy (Fig. 9). There was no evidence of parenchymal involvement. Additional study four months later showed evidence of further enlargement of the dense paratracheal shadows, with evidence of effusion on the right side (Fig. 10).

Surgical exploration was performed and biopsy confirmed the diagnosis of tuberculous peritonitis. The patient was transferred to a sanatorium, but failed to recover.

Case 8. B. T., Negro male, aged 16, was admitted with a history of gradually increasing fatigue and weakness for one month and a dry, non-productive cough for two weeks. Physical examination revealed emaciation and typical phthisical habitus. Physical signs yielded little, and there was some disagreement regarding the presence of an intrathoracic lesion.

X-ray study of the chest (Fig. 11) revealed the presence of enlarged glands pro-

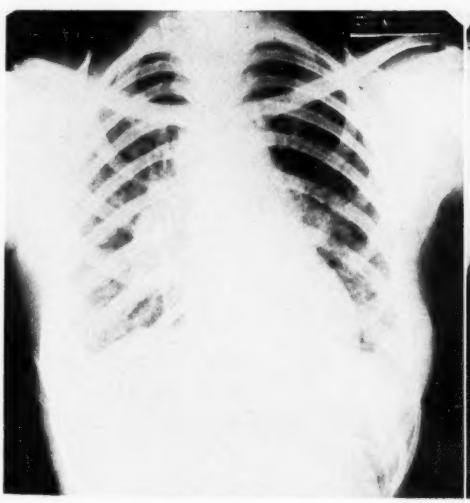

Fig. 7.

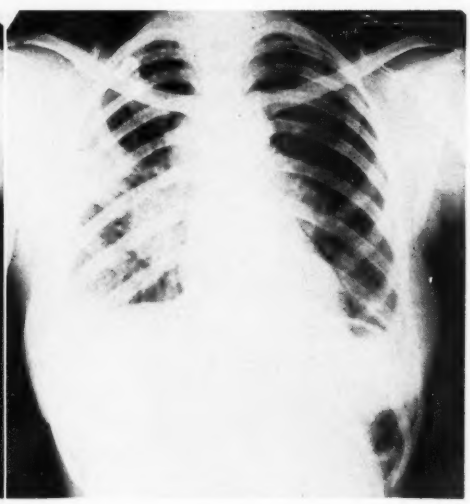

Fig. 8.

Fig. 7. Case 6. A. S., female Negro, aged 24. Cough and low grade fever. Bilateral hilar and right paratracheal adenopathy.

Fig. 8. Same case as shown in Figure 7, four months later. Increase in size of right hilar and mediastinal glands with tuberculous lesions of right lung and pleura.

jecting from the right hilum and producing widening of the upper mediastinum.

Numerous sputum examinations were negative for tuberculosis. The tempera-

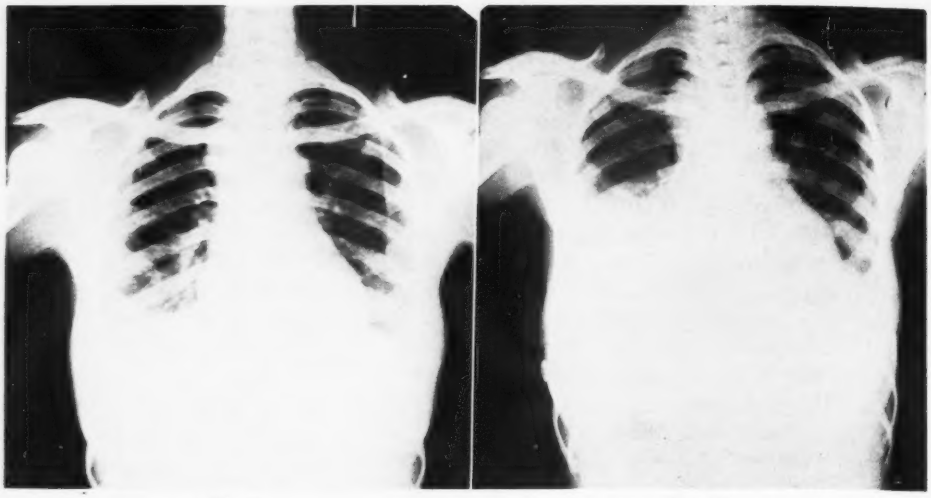

Fig. 9. Fig. 10.

Fig. 9. Case 7. L. J., female Negro, aged 26. Swelling of abdomen, cough and slight fever for two months. Sharply outlined paratracheal adenopathy on right. No pulmonary involvement.
Fig. 10. Same case as shown in Figure 9, four months later. Gradual enlargement of mediastinal mass with tuberculous involvement of right pleura.

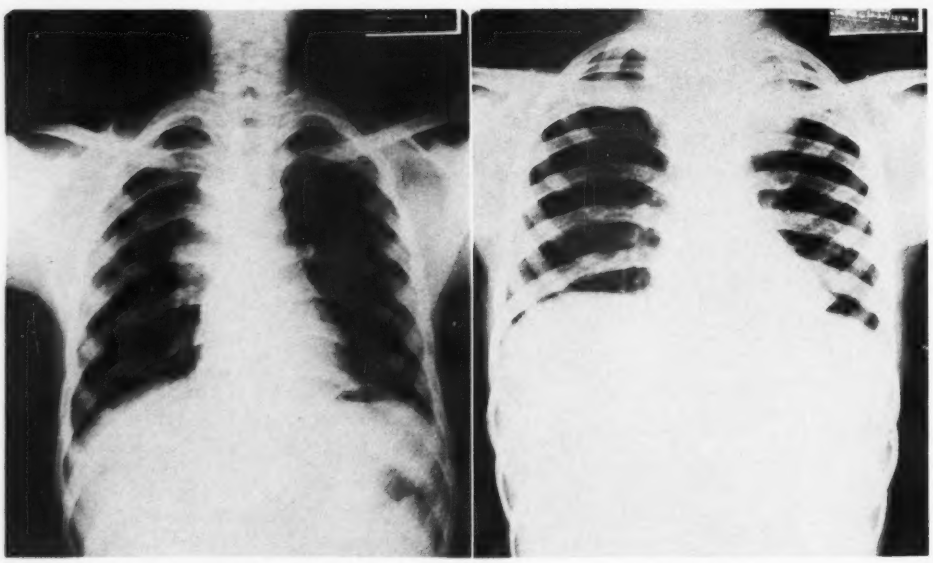

Fig. 11. Fig. 12.

Fig. 11. Case 8. B. T., Negro male, aged 16. Non-productive cough and weakness. Well demarcated right hilar and paratracheal tuberculous adenopathy. Beginning glandular enlargement in left paratracheal region. No parenchymal involvement. Tuberculin test positive.
Fig. 12. Case 9. R. S., Negro male, aged 19. Enlarged cervical glands for three years. Bilateral upper mediastinal adenopathy for at least two years. No pulmonary involvement. Tuberculous peritonitis and tuberculosis of bones, developed five months before examination. Improved on bed-rest.

ture was normal, and blood serology and chemistry studies were essentially negative. The tuberculin test was strongly positive. Collapse therapy was instituted on the right side, but was discontinued after nine refills. The patient remained in the hospital for three months. He gained 30 pounds and his general health improved remarkably. He was discharged to a sanatorium, where his condition continued to improve.

Case 9. R. S., Negro male, aged 19, was admitted with a history of enlarged glands in the neck for three years, soreness of the wrist and ankle joints for five months, and swelling of the abdomen for two months. He had been treated at various institutions for cervical adenitis. Biopsy confirmed the diagnosis of tuberculous origin. X-ray studies at other hospitals revealed enlargement of upper mediastinal glands two years prior to admission. Sputum studies were negative, and x-ray studies a year prior to admission revealed similar mediastinal adenopathy.

X-ray studies on two occasions following admission revealed extensive upper mediastinal glandular masses, but no evidence of parenchymal involvement (Fig. 12). Tuberculous involvement of the left wrist, ankle, and lower thoracic spine, together with tuberculous peritonitis, was evident. The latter was confirmed by exploratory laparotomy and biopsy. The patient was discharged in improved condition after six months' hospitalization.

SUMMARY

1. Tuberculosis of the hilar and mediastinal glands in adults is discussed on the basis of 65 cases seen at the Philadelphia General Hospital in the past six years. Of these, 32 represent the result of combined roentgen and autopsy findings.

2. There are no criteria for roentgen diagnosis of tuberculous hilar or mediastinal node enlargements in adults, since these may be the result of a variety of pathologic processes. Moderate involvement frequently simulates the so-called childhood type.

3. Diagnosis depends on correlation of roentgen findings with the clinical and physical findings, the subsequent clinical course of the case, and comparative roentgen examinations. Roentgen radiation is sometimes a valuable diagnostic and therapeutic adjunct.

4. Roentgen therapy has not proved harmful, and there is clinical evidence to suggest beneficial results following its use.

REFERENCES

(1) KORNBLUM, KARL, and COOPER, D. A.: Tuberculous Mediastinitis. Am. Jour. Roentgenol. and Rad. Ther., **23,** 276–285, March, 1930.

(2) Primary Tuberculosis in Adults (editorial). Jour. Am. Med. Assn., **113,** 146, 147, July 8, 1939.

(3) SOPER, WILLARD B., and AMBERSON, J. B., JR.: Pulmonary Tuberculosis in Young Adults, Particularly among Medical Students and Nurses. Am. Rev. Tuberc., **39,** 9–32, January, 1939.

(4) MILLES, GEORGE: Stenosis of the Superior Vena Cava Due to Mediastinal Tuberculosis. Arch. Int. Med., **50,** 759–765, November, 1932.

(5) BUCKLEY, RICHARD C.: Tuberculosis of the Anterior Mediastinal Lymph Nodes. Am. Rev. Tuberc., **17,** 383, June, 1928.

(6) PFAHLER, G. E.: Mediastinal Glandular Tuberculosis in the Adult Resembling Hodgkin's Disease: Recovery of Case. Am. Jour. Roentgenol. and Rad. Ther., **41,** 742–748, May, 1939.

DISCUSSION

JOSEPH H. GREEN, M.D. (Rochester, N. Y.): Were the mesenteric lymph nodes involved? Were the mediastinal lymph nodes also involved?

ARTHUR R. BLOOM, M.D. (Detroit): Was the sputum positive? And do you have hemoptysis in those cases?

B. P. WIDMANN (*closing*): I can only emphasize again the importance of considering the possibility of tuberculosis of the hilar and mediastinal nodes even when there may be a borderline or doubtful enlargement, particularly when associated with atypical clinical and physical findings. I cannot answer definitely the Doctor who spoke. Many of these cases at postmortem did show, in the terminal stages, pulmonary involvement with cavitation, hemorrhage, and sputum positive for tubercle bacilli. These pulmonary findings never occurred in the early stages of roentgenographic evidence of tuberculous adenopathy to the hilar and mediastinal nodes in adults. Tuberculin tests were always strongly positive.

INTRACTABLE HEARTBURN OF PREGNANCY[1]

By JOHN R. EVANS, M.D., *and* JOHN S. BOUSLOG, M.D., *Denver, Colorado*

HEARTBURN of pregnancy is a symptom usually passed over lightly and given little attention by the obstetrician. It is true that there are mild and intermittent forms which are not intensely disturbing to the patient, and in which the casual use of antacids, alkaline salts, and sedatives gives adequate and prompt relief. But there is another rather large group of patients in whom the symptoms are constant, more severe, and not relieved by any known treatment. It is this group which we designate as having the intractable heartburn of pregnancy. The syndrome usually appears about the twentieth to twenty-fifth week and continues with increasing severity until labor is completed. Following delivery, relief is immediate and complete unless there have been symptoms in the previous non-pregnant state.

It was the accidental radiologic finding of one of us (J. R. E.) five years ago that led to the diagnosis of the condition as that of esophageal orifice hernia. Subsequent roentgen studies have shown that this is the causative factor in all of these cases examined to date. The etiology of the condition is, of course, no different from that occurring in non-gravid individuals. It may not be amiss to quote briefly from Dwyer who discusses the embryological factor in the etiology of this as well as other herniæ:

"The size of the esophageal hiatus may vary considerably. Embryologically this defect is due to the fact that the development of that portion of the diaphragm derived from the dorsal mesentery and the mesoderm of the receding wolffian body leaves not only a defect of varying extent in the muscular and tendinous structures but often leaves also a deformity in the conformation of the dome of the diaphragm and a shortening of the esophagus. Esophageal hiatus herniæ are essentially congenital in the same sense that herniæ in the inguinal regions are congenital. Due to a deficiency in the embryological development, there may be a congenital weakness of the esophageal ring, and, as in an inguinal hernia, later on in life, through trauma, or any increase in intra-abdominal pressure, a definite hernia may develop."

There is, however, a marked difference in the constancy of the symptomatology in gravid and in non-gravid individuals. According to various authors, the symptoms in non-gravid individuals vary markedly from vague and non-specific ones to those of intense abdominal or thoracic distress. The usual symptom is that of epigastric discomfort or pain, usually aggravated by the taking of food but with no definite time-relation to eating. Occasionally the distress is severe enough to simulate biliary colic and may have the same radiation. Most cases exhibit various combinations of the symptoms of belching, heartburn, nausea, regurgitation, and vomiting. All authors stress the relation of the latter symptoms to posture, the upright position usually giving some measure of relief. The thoracic symptoms, when present, consist of palpitation, dyspnea, and paroxysmal and non-productive cough.

In the gravid individuals we have observed, the symptoms are constant and increasing in severity. The universal symptoms of "heartburn," well described by that word, are accompanied by a sensation of burning along the entire course of the esophagus. There is effortless regurgitation not accompanied necessarily by vomiting sensations or belching. Posture plays a more important part in these cases than in the non-gravid. As the pregnancy continues, with the progressive increase in intra-abdominal pressure, the only relief obtainable is by maintenance of the upright or semi-upright position. We

[1] Accepted for publication Feb. 28, 1939.

have had several patients who have been unable to assume the recumbent position for several months before term without extreme suffering. This is easily understandable when the action of the barium meal is watched under the fluoroscope. The horizontal fluctuation of the bolus is seen, with intervals in which the esophagus remains completely full. The sensation of burning probably bears no relation to the reaction of the material. In those cases in which gastric analyses were made during the height of the symptoms, the reaction varied from an anacidity to normal acidity with the former reaction predominating. In only one case did we find a hyperacidity, this being in a woman who had a gastric ulcer. These findings sug-

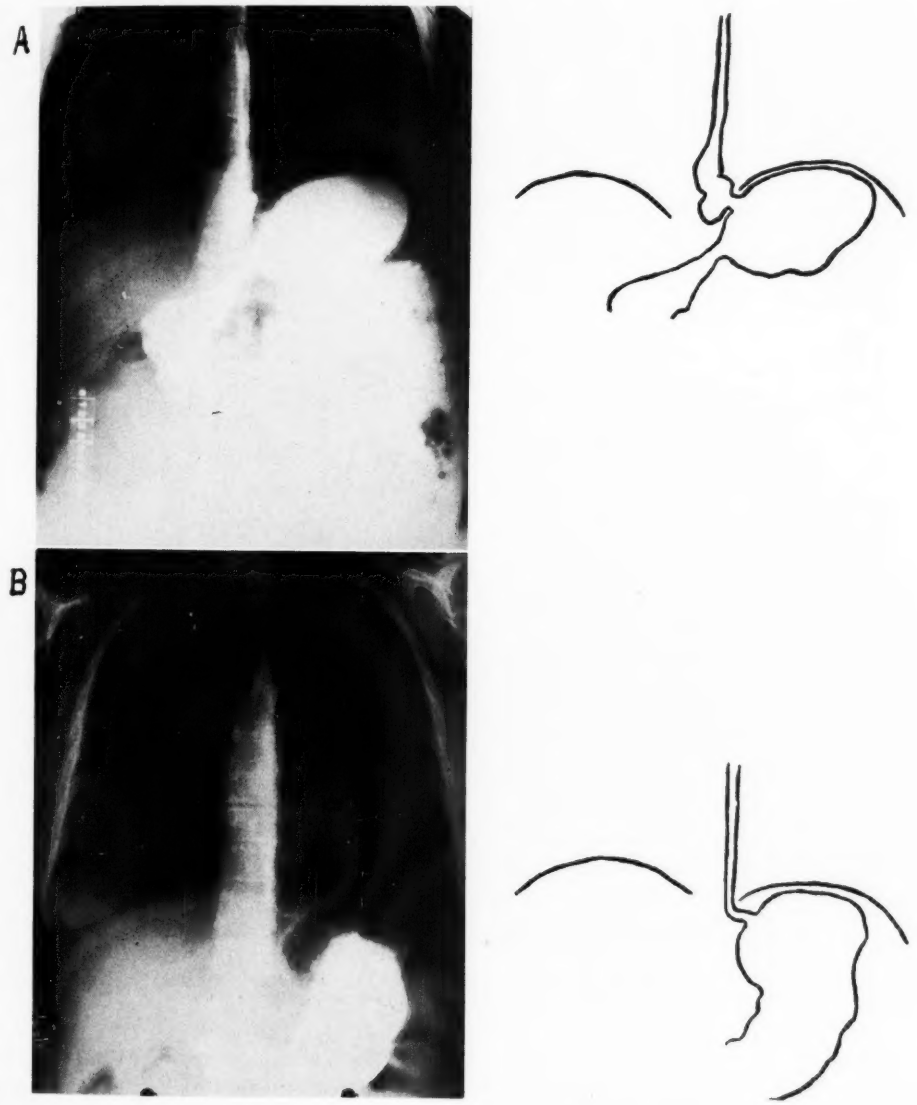

Fig. 1. *A*, Examination at the thirty-sixth week, showing the herniation. Schematic diagram on the right. *B*, Examination ten days postpartum, showing no herniation.

gest the reason for the lack of relief from antacids and ulcer types of diet. Dilute hydrochloric acid has been given with food with no increase in the severity of the symptoms. The burning sensations are elicited probably by any substance, including water, because of the inherent sensitivity of the mucosa of the esophagus, the function of which is merely that of a connecting tube with no digestive function.

The following case histories illustrate this condition.

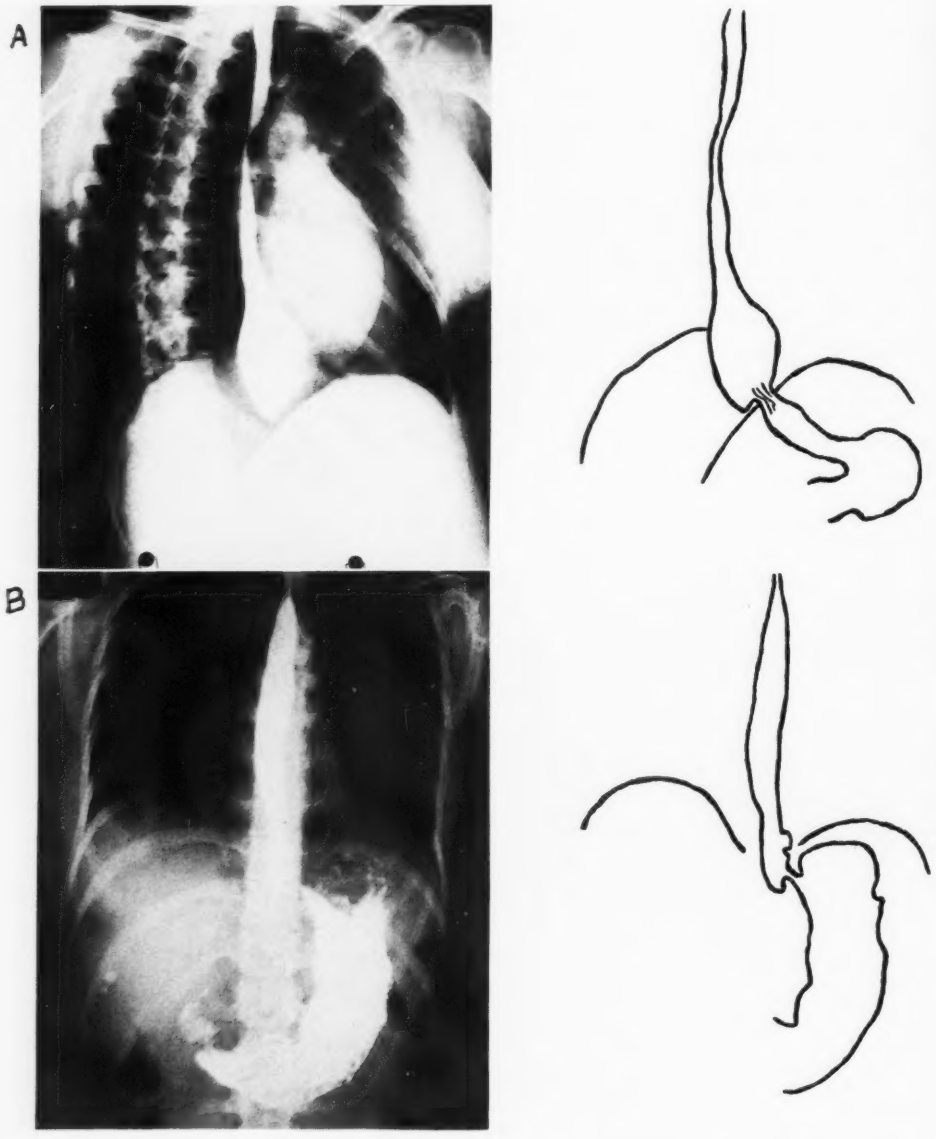

Fig. 2. *A*, Examination at the twenty-seventh week, showing the herniation. Schematic diagram on the right. *B*, Examination five months postpartum, showing no herniation.

Case 1. Mrs. J. N., aged 28, primipara. Intractable heartburn appeared about the twenty-eighth week of gestation. Increased rapidly in severity. She was unable to lie down without heartburn from about the thirty-second week until pregnancy terminated. The pregnancy was otherwise uncomplicated. Subjective symptoms entirely disappeared by the third postpartum day.

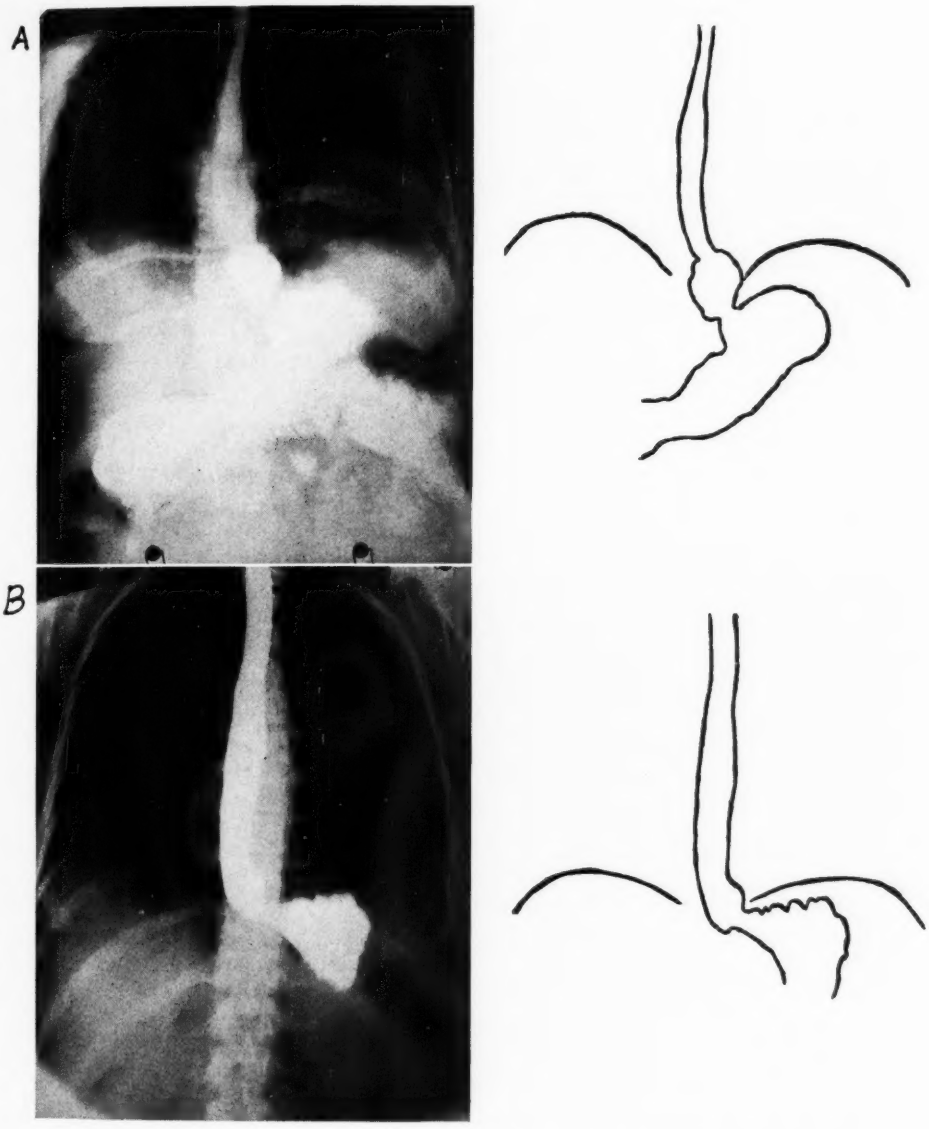

Fig. 3. *A*, Examination at the thirty-sixth week, showing the herniation. Schematic diagram on the right. *B*, Examination four months postpartum, showing no herniation.

Case 2. Mrs. R. J. Y., aged 27, gravid IV. Three previous pregnancies had ended in

spontaneous miscarriage before the twelfth week. Symptoms of intractable heartburn appeared at the twenty-seventh week of gestation. She was unable to lie flat with comfort until 3 or 4 A.M., when she could assume the supine position with comfort. Severity gradually increased until two weeks before delivery when some spontaneous relief was noted. Subjective symptoms disappeared within the first postpartum week. Pregnancy was otherwise uncomplicated.

Case 3. Mrs. Z. C., aged 34, primipara. Her symptoms of intractable heartburn began at the thirty-second week of gestation, complicated by frequent en-

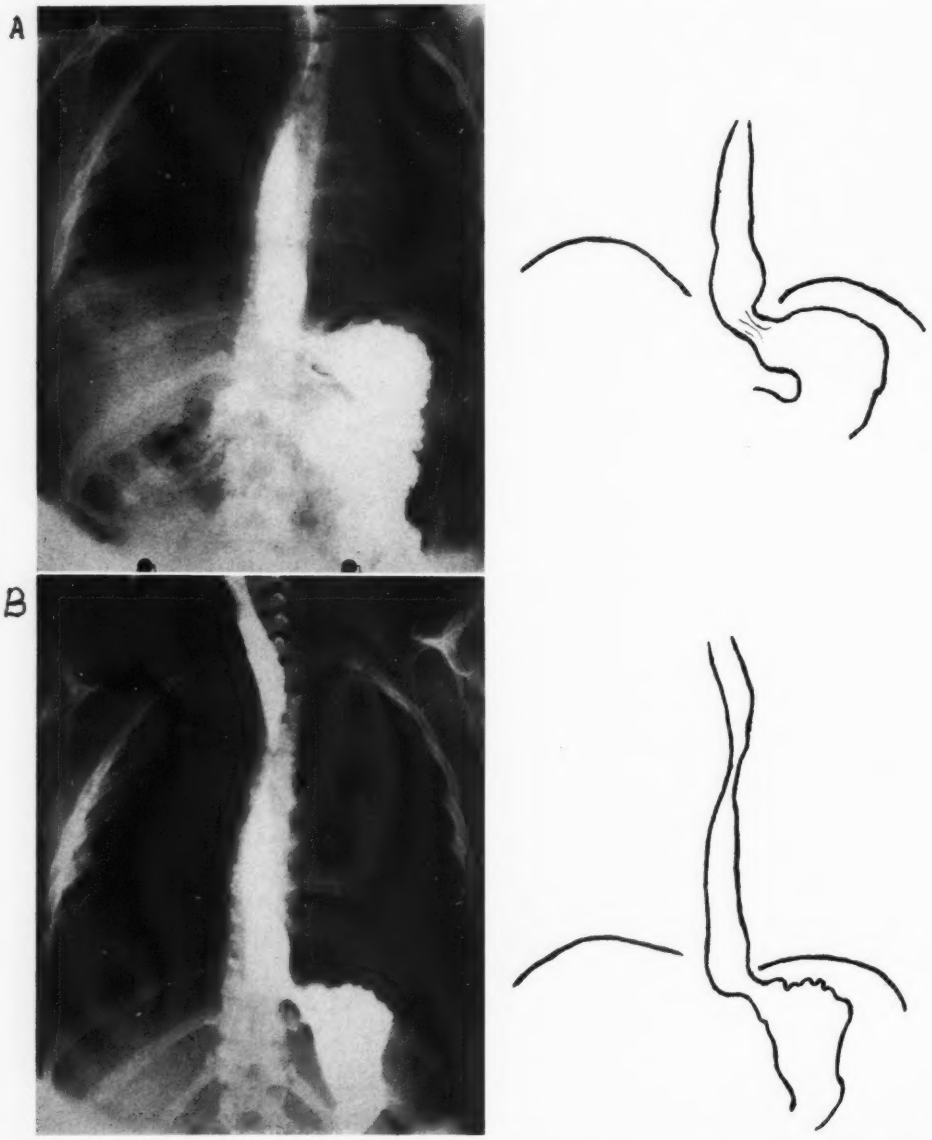

Fig. 4. *A*, Examination at the twenty-eighth week, showing the herniation. Schematic diagram on the right. *B*, Examination one month postpartum, showing no herniation.

uresis. Symptoms increased gradually in severity until pregnancy was completed. Frequency complicated by essential hypertension of 15 years' duration. Delivery complicated by contraction ring and death of fetus. Subjective symptoms persisted in mild form for four or five weeks postpartum.

Case 4. Mrs. I. B., aged 38, primipara. Her intractable heartburn appeared at the twenty-sixth week of gestation, with the additional symptom of effortless enuresis. She was unable to lie down during the early part of the night, but could lie down with moderate comfort for the latter part of the night. Had symptoms of burning, present at all times when conscious. Pregnancy was complicated by the presence of uterine fibroids of at least five years' duration. Symptoms were relieved in the first few postpartum days.

As to treatment, nothing we have tried to date gives much promise of success. Antacids seem to give slight relief if belching is produced. Ulcer types of diet have been disappointing. Salines and pyloric relaxants have produced little or no change. Further experiments are being conducted, however, in the hope of giving some relief to a distressing condition which renders the latter few months of pregnancy almost unbearable.

SUMMARY

Intractable heartburn of pregnancy is caused by an esophageal orifice hernia. This is produced by increased intra-abdominal pressure due to the enlarging uterus. The symptoms are constant and increasing in severity and are due to the constant irritation of the esophageal mucosa. No form of treatment attempted thus far has been efficacious.

BIBLIOGRAPHY

PANCOAST, H. K., and BOLES, R. E.: Non-traumatic Left Diaphragmatic Hernia. Arch. Int. Med. **38,** 633–646, November, 1926.

RITVO, M.: Diaphragmatic Hernia. Jour. Am. Med. Assn., **94,** 15–21, Jan. 4, 1930.

WAGNER, AAGE: Esophageal Orifice Hernia. Acta Radiol., **13,** 466–482, 1932.

DWYER, MAURICE F.: Hernia of the Cardiac End of the Stomach through the Diaphragm. RADIOLOGY, **28,** 315–323, March, 1937.

ÅKERLUND, A., OCHNELL, H., and KEY, E.: Hernia Diaphragmatica Hiatus Oesophagel, "Der Hiatusbruch." Acta Radiol., **6,** 3–22, 1926.

WHY THE FILM SIZE?[1]

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THE question proposed may appear of minor significance compared to the many important problems of roentgenology. However, each roentgenologist has, in the course of the activities of his own practice, many times wondered, Why the film size? The physical dimensions of the x-ray film currently manufactured for our purpose appear to have followed the standard sizes used for generations in the photographic industry. Upon investigation, no other reason could be discovered.

All have experienced the dissatisfaction of being unable to obtain a demonstration of the entire barium-filled colon on one film, and, on the other hand, it is frequently observed that the lower third of the chest film is useless from a diagnostic standpoint, and, therefore, wasted. The films now in use are occasionally too short for demonstration of the entire urinary tract on one film, presenting difficulty in proper positioning, while at the same time there is considerable waste in the width of the film. The present sizes are poorly adapted to skulls, long bones, etc. Why not a change to closer conformity to anatomy?

While perfection is not to be expected, we believe that some stimulus is necessary toward the study of more suitable film dimensions. Mindful of the requisite changes of radiographic equipment (cassettes, hangers, tanks, etc.) which would be involved, we are advancing the following computations for the possible consideration of the various national roentgen societies, in an attempt to initiate a movement which might gradually but eventually lead to obtaining more satisfactory supplies to the advantage of the patient and the roentgenologist.

Offhand, one immediately anticipates tremendous changes in equipment but on further thought it may be noted that for a time the only serious difficulties would be for a new size for the colon, about 3 per cent of the work in certain x-ray departments, and which could be avoided by a method to be described later. Those processing systems with insert tanks may be used with little change. Films smaller than those used at present may be continued in service by using frames in cassette-changers and holders.

It is with reluctance that any set of sizes is suggested at this time, realizing, as we do, that no set of sizes will ever prove perfect in all cases. For the purpose of instigating further thought on these lines, a table of suggested sizes is offered.

In order to secure some basis for computation, an analysis of the diagnostic limits of the usual anatomic roentgen shadows was made in a series of routine

TABLE I.—AXIAL

Number below 11 inches	233 or 46.6%
Number between 11 and 12 in. (not inclusive)	118 or 23.6%
Number between 12 and 13 in. (not inclusive)	98 or 19.6%
Number between 13 and 14 in. (not inclusive)	42 or 8.4%
Number between 14 and 15 in. (not inclusive)	9 or 1.8%
Average axial diameter	11.01 in.
Smallest axial diameter	7.0 in.
Largest axial diameter	14.62 in.
Percentage over average	50.8%

TABLE II.—TRANSVERSE

Number below 11 inches	225 or 45.0%
Number between 11 and 12 in. (not inclusive)	149 or 29.8%
Number between 12 and 13 in. (not inclusive)	95 or 19.0%
Number between 13 and 14 in. (not inclusive)	20 or 4.0%
Number between 14 and 15 in. (not inclusive)	7 or 1.4%
Number 15 in. and over	4 or 0.8%
Average transverse diameter	11.17 in.
Smallest transverse diameter	8.25 in.
Largest transverse diameter	15.50 in.
Percentage over average	48%

[1] Submitted for publication in January, 1940

adult cases in Kings County Hospital, Brooklyn, N. Y.

CHEST MENSURATION

Series A.—Five hundred consecutive adults, with an unselected film-target distance (36 to 72 inches).

The axial diameter (vertical diagnostic limit) was taken as the mid-line distance on the film from the level of the upper border of the first dorsal vertebra to the intersection with the transverse diameter, as described in Table I.

TABLE III.—AXIAL

Number below 11 inches	245 or 49.0%
Number between 11 and 12 in. (not inclusive)	127 or 25.4%
Number between 12 and 13 in. (not inclusive)	74 or 14.8%
Number between 13 and 14 in. (not inclusive)	48 or 9.6%
Number between 14 and 15 in. (not inclusive)	5 or 1.0%
Number 15 in. and over	1 or 0.2%
Average axial diameter	10.98 in.
Smallest axial diameter	7.12 in.
Largest axial diameter	15.0 in.
Percentage over average	50.1%

TABLE IV.—TRANSVERSE

Number below 11 in.	219 or 43.8%
Number between 11 and 12 in. (not inclusive)	171 or 34.2%
Number between 12 and 13 in. (not inclusive)	89 or 17.8%
Number between 13 and 14 in. (not inclusive)	21 or 4.2%
Number 14 in. and over	0
Average transverse diameter	11.01 in.
Smallest transverse diameter	7.50 in.
Largest transverse diameter	13.75 in.
Percentage over average	47.6%

TABLE V

Average height of 200 patients	65.58 in.
Lowest height of 200 patients	4 ft. 4 in.
Greatest height of 200 patients	6 ft. 2 in.
Under 5 feet	4.5%
Between 5 ft. and 5 ft. 6 in.	45.5%
Between 5 ft. 6 in. and 6 ft	47.0%
6 feet and over	3.0%
Average axial diameter on the film	11.11 in.
Lowest axial diameter on the film	8.0 in.
Greatest axial diameter on the film	15.0 in.
Average transverse diameter on the film	10.75 in.
Lowest transverse diameter on the film	8.75 in.
Greatest transverse diameter on the film	13 1/8 in.

The transverse diameter (horizontal diagnostic limit) was measured from the outer border of the ribs on the film, at the level of the costophrenic sulcus.

From the figures shown in Tables I and II it might be noted that 100 per cent of these cases, postulating perfect positioning to demonstrate the point, would have a complete diagnostic shadow on a 15 × 15.5 in. film; 98 per cent of them could be obtained on a 14 × 14 in. film; 93.8 per cent would be complete on a 13 × 14 in. film, and 89.8 per cent on a 13 × 13 in. size.

Series B.—Five hundred consecutive adult chests, with a film-target distance of 72 inches (Table III).

One hundred per cent of the cases in the series shown in Tables III and IV would be included in an area of 15 × 14 in.; 98.8 per cent in 14 × 14 in.; 95.8 per cent in 14 × 13 in., and 89.2 per cent in 13 × 13 inches.

Series C.—Two hundred cases, with a film-target distance of 72 inches, were measured to determine any possible relationship between the patient's height and the axial diameter of the chest on the film.

The figures shown in Table V disclose no practical relationship. The axial diameter appears to be in accordance with the habitus of the patient, rather than with his height.

ACCURACY OF POSITION LATERALLY

Series D.—In order to evaluate the accuracy of a capable technician in posturing the patient and obtaining the entire chest on the present 14 × 17 in. film, a measurement was made of the lateral portions of the roentgenograph from the outer border of the ribs at the costophrenic angle to the edge of the film. One hundred routine adult 6-foot chest films were examined.

From the data shown in Table VII we note that this individual technician obtained perfect centering, while doing routine cases, in 12 per cent of this chest series. In 87 per cent of the cases his inaccuracy did not exceed 1 inch; in 13 per cent the patient was off-center over 1 inch; in only one case was a portion of the thorax off the film (1/2 inch).

TABLE VI.—RELATION OF PATIENT'S HEIGHT AND THE AXIAL DIAMETER

Height	Axial diameter						
	8–9 in.	9–10 in.	10–11 in.	11–12 in.	12–13 in.	13–14 in.	14–15 in.
74 in.				1			
73 in.				1		1	2
72 in.			1				
71 in.				2	3		
70 in.	4		1	5	4	2	
69 in.			2	2	2	2	1
68 in.		2	1	6	2	2	
67 in.		2	6	9	5	1	
66 in.		3	7	12	10	1	
65 in.		5	5	10	5		
64 in.	1	5	5	10	3		
63 in.	2	1	5	3			
62 in.	1	1	10	5	1		
61 in.			3	2		1	
60 in.	1		1				
59 in.	1	2	3				
58 in.			3				
57 in.							
56 in.							
55 in.							
54 in.							
53 in.							
52 in.	1						

200 COLONS

The axial diameter is measured from the top of the higher flexure to the anus.

The transverse diameter is measured from the lateral borders of the colon.

TABLE VII

No asymmetry (perfect positioning)	12
One-eighth inch asymmetry	9
One-quarter inch asymmetry	22
Three-eighths inch asymmetry	6
One-half inch asymmetry	13
Five-eighths inch asymmetry	9
Three-quarters inch asymmetry	4
Seven-eighths inch asymmetry	5
One inch asymmetry	7
One and one-eighth inch asymmetry	4
One and one-quarter inch asymmetry	3
One and three-eighths inch asymmetry	1
One and one-half inch asymmetry	2
One and five-eighths inch asymmetry	1
Two inch asymmetry	1
Two and one-quarter inch asymmetry	1

The film–target distance was 30 inches, in postero-anterior position (Table VIII).

Percentage of cases in which measurements had to be estimated by superimposing films or by extrapolation (*i.e.*, off the film): axial, 41.5 per cent; transverse, 11.5 per cent.

These figures direct our attention to the inadequacy of the present length of film (17 inches), as in this series the full length of the colon could not be obtained on one film in 41.5 per cent of cases. A length of 20.5 in. would encompass 100 per cent, 19 in. for 95.5 per cent, and 18 in. for 81.5 per cent. Transversely, 17 in. for 100 per cent, 16 in. for 98 per cent, 15 in. for 95 per cent, and 14 in. for 88.5 per cent.

TABLE VIII

Average axial diameter	16.35 in.
Minimum axial diameter	11.00 in.
Maximum axial diameter	20.50 in.
16 to 17 in. (not inclusive)	19. %
17 to 18 in. (not inclusive)	23.5%
18 to 19 in. (not inclusive)	13.5%
19 to 20 in. (not inclusive)	4.0%
20 in	0.5%
Percentage below 16 in	39.5%
Average transverse diameter	12.29 in.
Minimum transverse diameter	9.0 in.
Maximum transverse diameter	17.0 in.
9 to 10 in	3.5%
10 to 11 in	13.0%
11 to 12 in	30.5%
12 to 13 in	25.5%
13 to 14 in	16.0%
14 to 15 in	6.5%
15 to 16 in	3.0%
16 to 17 in	1.5%
17 in	0.5%

TABLE IX

Average axial	14.35 in.	
Minimum axial	12.12 in.	
Maximum axial	17.50 in.	
14 to 15 in. (not inclusive)		47.0%
15 to 16 in. (not inclusive)		24.5%
16 to 17 in. (not inclusive)		5.0%
17 in		0.5%
Percentage below 14 in		23.0%
Average transverse	8.65 in.	
Minimum transverse	6.25 in.	
Maximum transverse	10.75 in.	
6 to 7 in. (not inclusive)		0.5%
7 to 8 in. (not inclusive)		19.5%
8 to 9 in. (not inclusive)		39.0%
9 to 10 in. (not inclusive)		31.5%
10 to 11 in. (not inclusive)		9.5%
11 and over		0.

TABLE X

Average *A* diameter	8.37 in.	
Minimum *A* diameter	6.62 in.	
Maximum *A* diameter	9.50 in.	
8 to 9 in. (not inclusive)		72.0%
9 to 10 in. (not inclusive)		12.5%
10 or over		0
Percentage below 8 in		15.5%
Average *B* diameter	6.75 in.	
Minimum *B* diameter	5.50 in.	
Maximum *B* diameter	8.75 in.	
6 to 7 in. (not inclusive)		66.0%
7 to 8 in. (not inclusive)		27.5%
8 and over		2.5%
Percentage below 6 in		4.0%
Average *C* diameter	6.56 in.	
Minimum *C* diameter	5.88 in.	
Maximum *C* diameter	8.00 in.	
6 to 7 in. (not inclusive)		87.0%
7 to 8 in. (not inclusive)		11.5%
8 or over		0.
Percentage below 6 in		1.5%

200 KIDNEYS

The axial diameter is measured from the top of the higher kidney to the mid-symphysis pubis (prostate area).

The transverse diameter is measured from the lateral borders of the kidneys.

In the series shown in Table IX, 100 per cent of cases would be included in a width of 11 inches, if perfectly positioned. A length of 17 in. would secure 99.5 per cent; 16 in. for 94.5 per cent, and 15 in. for 70 per cent.

200 SKULLS

A is the longest anteroposterior diameter, including the nasal bones.

B is the supero-inferior diameter, from the vertex to the lower border of the basi-occiput.

C is the interparietal diameter. Target-film distance is 28 inches.

In the series shown in Table X, 97.5 per cent of the cases would be obtained on an area of 8 × 10 in. and 70 per cent on one of 7 × 9 in.

100 PELVES

The axial diameter was measured from the crest of the ilium to the inferior border of the pubic bone.

The transverse diameter was taken from the outer border of the greater trochanters.

Films were taken in an anteroposterior plane, with a film-target distance of 30 inches.

In the series shown in Table XI, 100 per cent of the cases would be included

TABLE XI

Average axial	9.12 in.	
Minimum axial	7.50 in.	
Maximum axial	10.62 in.	
7 to 8 in. (not inclusive)		2.0%
8 to 9 in. (not inclusive)		39.0%
9 to 10 in. (not inclusive)		46.0%
10 and over		0.
Average transverse	13.20 in.	
Minimum transverse	10.50 in.	
Maximum transverse	16.00 in.	
10 to 12 in. (not inclusive)		4%
12 to 13 in. (not inclusive)		35%
13 to 14 in. (not inclusive)		40%
14 to 15 in. (not inclusive)		17%
15 and over		4%
16 in		0.

TABLE XII.—AREA NECESSARY IN PERCENTAGE OF CASES

		Percentage (when perfectly centered)									
		100%	99%	98%	95%	94%	90%	89%	80%	79%	70%
Chest (1,000)	INCHES	15.5 × 15	15 × 14	14 × 14	14 × 14	14 × 13	14 × 13	13 × 13	13 × 13	13 × 13	13 × 13
Colon (200)		20.5 × 17	20 × 17	20 × 16	19 × 15	19 × 15	19 × 15	19 × 15	18 × 14	18 × 14	18 × 14
Urinary Tract (200)		17.5 × 11	17 × 11	17 × 11	16 × 11	16 × 11	16 × 10	16 × 10	16 × 10	16 × 10	15 × 9
Skull (200)		10 × 8	10 × 8	10 × 8	10 × 8	10 × 8	10 × 8	10 × 8	10 × 7	10 × 7	9 × 7
Pelvis (100)		15 × 11	15 × 11	15 × 11	15 × 11	15 × 11	15 × 11	15 × 11	15 × 11	14 × 10	14 × 10

in an area of 11 × 15 in., with a length of 10 in. for 87 per cent, and a width of 14 in. in 79 per cent.

As a summary, Table XII presents computed areas necessary to encompass the measurements in these series. These figures do not allow latitude in positioning and this point must be considered separately. One or two inches may be added to each diameter to insure latitude for imperfect centering of the patient. In one series, a technician needed only one inch leeway for perfect chest centering in 87 per cent of the cases (transverse diameter) and was able to obtain 99 per cent of these examinations complete on the film, without being aware that his routine positioning was undergoing scrutiny.

From an analysis of Tables I–XII, we offer the following suggested film sizes as practicable for the vast majority of cases, although it is obvious that perfect adaption for every patient is not possible. The advantage is that these sizes will be closer to the usual anatomical dimensions.

TABLE XIII

16 × 20 in.	Colon (or two 12 × 17 in. placed crosswise)
15 × 15 in.	Chest
12 × 17 in.	Urinary tract, vertebræ, pelvis
9 × 11 in.	Skull, biliary tract, joints
7 × 9 in.	Nasal sinuses, mastoids, hands, feet, small joints
5 × 7 in.	Small parts

With one inch to spare on each measurement and with proper posturing, 95 per cent of all examinations could be completely contained on the following film sizes (Table XIII):

By using two 12 × 17 in. films for the colon, placed transversely for the upper and lower portions of the large bowel, no change in the size of processing tanks would be necessary at this time. In effect, the only alterations immediately essential for the above new sizes would involve cassettes, hangers, and the films.

SUMMARY AND CONCLUSIONS

(1) Anatomical measurements of diagnostic limits were taken from the roentgenographs of routine cases and indicate the need for x-ray films of more suitable sizes.

(2) Specifically, the colon films were found to be too short, the chest films too long, and the urologic roentgenographs too wide. The present films are also poorly adapted for examination of the skull and other portions of the body.

(3) To secure a film sufficiently large to roentgenograph a part in entirety and to eliminate wastage, it seems advantageous that a film standardization program be adopted by the technical committees of the national roentgen societies.

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IRRADIATION AND HEREDITARY MAMMARY CANCER[1, 2]

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THIS study deals with the effect of irradiation on tissues destined, by the law of averages, to develop spontaneous neoplasms of the breast in 64 out of 100 instances. It is not definitely known whether or not small doses of x-ray or other irradiation applied to animal tissues bearing this tendency would facilitate or inhibit the speed of appearance or the incidence of cancer of the breast.

The broad knowledge regarding mammary cancer in mice prompted our selection of this tumor type as the experimental material for study. Before proceeding further it is essential to review briefly the literature regarding the causes which are thought to be concerned in the malignant degeneration of the breast tissue of such mice. It appears well established that mammary cancer in mice may be accepted as due to the action of ovarian hormones on the hereditarily conditioned mammary tissue (Loeb, 1; Lacassagne, 2; Burrows, 3; Bonser, 4, and others). The conditioned mammary tissue seems to be characterized by an unusual response or an extremely susceptible reaction to the ovarian endocrines (Cramer, 5).

Estrogenic substances not of ovarian origin, materials acting like male sex hormones, and the endocrines of the pituitary gland cannot be wholly eliminated from consideration in the genesis of mammary cancer in such mice. It would seem that these agents might play some indirect or secondary rôle. Apparently the estrogenic substances, whether from extrinsic or intrinsic sources, are of primary importance in the genesis of mammary cancer (Suntzeff *et al.*, 6; Lacassagne, 7; Murray, 8; Geschickter and Astwood, 9, and Herold and Effkemann, 10). Endocrine stimulation certainly affects the time of tumor appearance and may thus really or apparently increase the incidence of tumors within specific age limits (Suntzeff *et al.*, 6; Geschickter and Astwood, 9, and Suntzeff *et al.*, 11). The number of litters borne seem not to parallel exactly the incidence of mammary cancer in the mother mouse although the multiparas do have an increased incidence of breast cancer. Bagg (12) observed an increase in the tumor incidence of very low tumor-rate strains, by mating mice and repeatedly breeding them without allowing the interference of a nursing period with the process of breeding. These are factors of an endocrine nature which might be affected by irradiation and which presumably could influence directly or indirectly the later incidence of spontaneous mammary cancer.

The experiment was planned as follows:

Group A—Low Dosage X-ray Group.—Female C3H mice were permitted to have and nurse one litter, after which they received x-ray therapy in minimum dosages. They were then caged and retained for 9.6 months, after which they were sacrificed and the breast tissue removed for study. The x-ray dosages were given when the animals were approximately four months of age.

Group B—High Dosage X-ray Group.—Similar to Group A except that higher dosages of irradiation were employed. The average age at sacrifice was 9.8 months.

Group C—Non-irradiated Control Group.—Four-month-old C3H females, after nursing and weaning one litter, were retained for 9.7 months. They were then sacri-

[1] Accepted for publication in June, 1939.

[2] Published with the permission of the Medical Director of the Veterans Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the authors.

ficed, the incidence of breast tumor noted, and histologic sections of the breast tissue made.

Group D—Colony Mother Group.—C3H females utilized for the colony propagation. The number of litters raised varied from one to four. No irradiation was given. The average age at sacrifice was 10.5 months. The incidence of tumor was noted and histologic slides of the mammary cancers were made and studied.

Group E—Non-bred Controls.—Female C3H mice were retained for 9.7 months without breeding. They were then sacrificed, the incidence of breast cancer was noted, and histologic sections of the breast tissues were prepared for study.

Group F—The Histologic Control Group.—Female mice of the same strain after the nursing and weaning of one litter were sacrificed and the breast tissues examined for cancer-cell nests. Age at the sacrifice averaged four months plus or minus two weeks. Over one thousand serial sections were prepared and studied. The material comprised all breast tissue of ten animals, none of which displayed malignant changes.

The mouse tumor strain (C3H) used displays adenocarcinoma of the mammary glands in 78 per cent of the multiparous females if a mean observance age of 10.7 months is used (Bittner, 13). The greatest number of these tumors appear between the ages of eight and twelve months. No carcinomas have been noted in the males. Usually less than 4 per cent of the non-breeding females develop mammary cancer. Cancer-free female mice of approximately four months of age were used in this study. We have never observed cancer in this strain at this early age.

For purposes of irradiation, shallow wooden boxes were used. These were constructed of 3 millimeter basswood and fitted with a glass top for observation. The sides and top of the boxes were provided with holes and spaces to allow for adequate ventilation.

Ten female mice were used for each dosage range. The radiation was given to the abdominal walls of the animals by inverting the tubes and supporting the animal boxes above the x-ray source. All dosages were checked with a standard dosimeter. Animals dying without cancer before the age limit set were discarded.

Standards for the deep x-ray were 140 kv., 20 ma., 1 mm. Al, 0.25 mm. Cu, and 3 mm. of basswood. The T.S.D. was 50 cm., delivery rate 17 r/min. For the superficial x-ray at 100 kv., 5 ma., filter of 3 mm. basswood, 20 cm. T.S.D. were the factors. The usual delivery rate was 201 r/min. When repeated dosages were

TABLE I.—SHOWING THE INCIDENCE, IN MICE, OF BREAST TUMORS FOLLOWING IRRADIATION

(Age of mice at time of irradiation was four months ± two weeks.)

Group	No. Mice	No. Tumors	Avg. Age (months)	Percentage Tumors	r Dose	No. Doses	Total r Given
A	9	3	9.3	33	100 D′	1	100
	4	2	9.4	50	51 S	2	102
	10	4	9.6	40	175 D′	1	175
Total	23	9		39			
B	6	1	9.6	16	100.5 S	4	402
	6	1	9.4	16	500 D′	1	500
	9	1	9.7	11	201 S	4	804
Total	21	3		14			
Total X-rayed	44	12		27			
C	26	17	9.7	65	None		
D	53	39	10.5	73	None		
E	25	1	9.6	4	None		
F	10	0	4.0	0	None		

D′ indicates deep x-ray, S indicates superficial x-ray

A, low dosage x-ray group
B, high dosage x-ray group
C, non-irradiated controls
D, colony mother group, no x-ray
E, non-bred controls, no x-ray
F, histologic controls, no x-ray

given, a lapse of one day between them was allowed. Attempts to screen out the head region were unsuccessful. The irradiation was thus applied to the whole ventral surface of the animals.

The findings, results, and general factors are illustrated in Table I. Four mice in Group *A* that received the low voltage of 100 r bore later litters and nursed them successfully. These are not included in the table.

Discussion.—Irradiation of the ventral surfaces of non-cancerous female mice of a high mammary cancer strain resulted in a decreased incidence of mammary tumors. The decrease in cancer incidence observed over a five-month post-irradiation period was roughly proportional to the irradiation dosages. X-ray dosages, both below and above the ovarian sterilizing amounts as given by Gricouroff (14), were effective. Irradiation dosages, three times that of the sterilization dose, were most effective. In no instance did irradiation increase cancer incidence, which is in contrast to the findings of Mottram (15) who used carcinogens and subsequent irradiation. None of the irradiation dosages caused an evident skin erythema. Some of the mice given the lower dosages subsequently raised second litters.

In explanation there is, of course, the possibility that the x-ray decreased or affected the ordinary non-pregnancy amounts of ovarian hormone, since the ovaries could not be ruled out of the field. The secretions of other hormones that might be suppressed by even mild doses of irradiation are prolactin, progestin, and the prolans. Increased production of these is commonly associated with breeding.

In line with Cramer's (*loc. cit.*) findings that mice of mammary tumor strain are more susceptible to estrogens, is the probability that certain cells in the mammary glands of the strain utilized are hereditarily destined to undergo malignant degeneration as the result of the endocrine stimulus coincidental with breeding. These cells in their non-cancerous state might then be more sensitive to x-ray than the other breast cells not carrying this latent cancerism. Plausibility is added to this interpretation in view of the fact that x-ray dosages beyond those effective for sterilization—as well as non-sterilizing doses—resulted in a proportionately decreased later incidence of cancer.

Considerable histologic evidence has demonstrated no apparent differences in the mammary gland cells of a comparable age-control group of mice sacrificed for breast tissues in this study. No nests of malignant cells were found in over a thousand serial sections of the breasts of these non-irradiated non-cancerous mice, similarly conditioned by the bearing of one litter. Present microscopic technic, however, may not be sufficient to demonstrate possible intracellular differences. Tumors that did develop despite irradiation were of the adenocarcinomatous type.

Have we here treated cancer successfully before it can be recognized histologically? This and other phases of the problem must be considered. The field of "latent cancerism" should be more thoroughly explored and investigations made of other types of spontaneous tumors, especially of those not definitely associated with endocrine factors.

SUMMARY

1. Small doses of irradiation (100 r) did not increase the incidence of breast cancer in non-breeding females of a high breast tumor strain of mice.

2. Irradiation dosages as low as 100 r, either superficial or deep x-ray, decreased the later incidence of spontaneous mammary cancer in the mouse strain C3H. Dosages of 402 r or over were more effective.

3. While some cancer suppression by means of depressing the sex endocrines may have occurred, it was noted that non-sterilizing dosages of radiation, as well as the higher dosages, were effective. The suppression, however, was proportional to the x-ray dosage.

4. Tissues at the time of irradiation

were non-cancerous as shown by histologic controls.

5. The concept is presented, that mammary cells bearing "latent cancerism" may be more susceptible to x-rays than are normal or definitely cancerous cells.

The authors wish to express their thanks to Max Cutler, M.D., A. C. Ivy, M.D., and L. H. Prince, M.D., for their interest and assistance in this study.

BIBLIOGRAPHY

(1) Loeb, Leo: The Interaction between Hereditary and Stimulating Factors in the Origin of Cancer. Acta, Union Internat. contre Cancer, **2,** 148–191, 1937.

(2) Lacassagne, A.: Apparition des cancers de la mamelle chez la souris mâle, soumise à des injections de folliculine. Compt. rend. acad. d. sci., **195,** 630–637, Oct. 10, 1932.

(3) Burrows, H.: Carcinoma Mammæ Occurring in Male Mouse under Continued Treatment with Oestrin. Am. Jour. Cancer, **24,** 613–616, July, 1935.

(4) Bonser, G. M.: Carcinoma of the Male Breast in Mice Induced with Oestrin: Effect of a Vitamin A Deficient Diet Combined with Oestrin Treatment. Jour. Path. and Bact., **41,** 217–222, 1935.

(5) Cramer, W., and Horning, E. S.: The Prevention of Spontaneous Mammary Cancer in Mice: By the Thyrotropic Hormone of the Pituitary Gland. Lancet, **1,** 72–76, Jan. 8, 1938.

(6) Suntzeff, V., Burns, E. L., Moskop, M., and Loeb, Leo: The Effect of Injections of Oestrin on the Incidence of Mammary Cancer in Various Strains of Mice. Am. Jour. Cancer, **27,** 229–245, June, 1936.

(7) Lacassagne, A.: Hormonal Pathogenesis of Adenocarcinoma of the Breast. Am. Jour. Cancer, **27,** 217–228, June, 1936.

(8) Murray, W. S.: Some Effects of Ovariectomy upon Breeding Females. Science, **75,** 646, 647, June 17, 1932.

(9) Geschickter, C. F., and Astwood, E. B.: The Relation of Oestrin and Other Hormones to Tumor Formation in the Breast: Some Fundamental Aspects of the Cancer Problem. Supp. to Science, **85,** 76–85, 1937.

(10) Herold, L., and Effkemann, G.: Beziehungen des Follikelhormons zu pathophysiologischen Wachstumsvorgängen der Brustdrüse; tier-experimentelle Untersuchungen über die Bedeutung einer langdauernden und vermehrten Follikelhormonwirkung in der Genese der Fibrosis mammae cystica. Arch. f. Gynäk., **163,** 94–101, 1936.

(11) Suntzeff, V., Burns, E. L., Moskop, M., and Loeb, Leo: On the Relation between the Incidence of Mammary Cancer and the Nature of the Sexual Cycle in Various Strains of Mice: Relative Constancy of Characteristics of Sexual Cycle in These Strains. Am. Jour. Cancer, **26,** 761–766, April, 1936.

(12) Bagg, H. J.: Functional Activity of the Mammary Gland in Relation to Extra-chromosomal Influence in the Incidence of Mammary Tumors. Science, **83,** 374, 375, April 17, 1936.

(13) Bittner, J. J.: The Breeding Behavior and Tumor Incidence of a Black Agouti Stock of Mice. Am. Jour. Cancer, **25,** 614–620, November, 1935; see also Science, 465, November, 1933.

(14) Gricouroff, G.: Étude histologique de l'action des rayons X sur l'ovarie à la periode d'ovagenesise. Arch. Inst. du Radium de l'Univ. de Paris, **2,** 1–80, 1930.

(15) Mottram, J. C.: Production of Epithelial Tumors by Irradiation of a Precancerous Skin Lesion. Am. Jour. Cancer, **30,** 746–748, August, 1937.

THE ILEOCECAL REGION[1]

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OBJECT OF STUDY

LIKE other parts of the digestive tract in which two sections of different width, structure, and digestive function join at a sphincter or a valve, the ileocecal region is a common site of motor disorder, inflammation, and newgrowth. Since the intrinsic and extrinsic factors which influence the passage through this junction combine in various ways, the appearances vary even in the selfsame person, and the results of postmortem studies and animal experiments cannot be applied to this problem of human physiology. But, as emphasized by Barclay (4), Hurst (13), and others, our conceptions of the function of the large and small intestines are based chiefly upon observations made on autopsy or in animals. Even the mechanics of the pylorus in man, on which extensive work has been done, is far from being fully understood; and what few publications there are on the ileocecal region, are not conclusive.

Since 1928, it has been the author's practice to observe systematically the ileocecal region in routine examinations whenever possible. Some of the results were published in previous papers (6, 17, 18). The present report is confined to an analysis of records obtained in 86 persons, apparently healthy. Special attention was given to the following questions:

1. How is the food moved on from the ileum into the cecum?
2. How does the food ascend through the cecum and proximal colon?
3. Is there any correlation between this kind of peristalsis and the passage of food through the ileocecal valve?
4. Does the ileocecal valve control the passage actively, by sphincteric contractions, or does it merely yield to pressure, like a valve?

METHOD

Unlike the filling of esophagus or stomach, the passage of an opaque medium through the ileocecal region cannot be controlled by the technical factors of the examination. Careful and repeated screen observations at many intervals have, therefore, to be made. Because various reflexes from the upper digestive tract affect the ileum in all normal cases (2, 4) a uniform method must be maintained. Our patients were prepared by a chamomile enema only, given the night before the examination; for it had been found that other forms of enemas, as well as laxatives, may produce transient irritation resulting in very marked alterations of tone, peristalsis, and position of the ileum and colon (Fig. 13). It was also noted that any kind of catharsis might lead to a slowing down of the passage through the colon as soon as the acute action had subsided. The patients received on an empty stomach at 8 A.M. a suspension of four tablespoonfuls of barium sulphate in 200 c.c. of water, the normal course of meals being resumed about one hour later. Five hours after ingestion of the opaque suspension, the ileocecal region was examined during periods varying between 15 minutes and several hours. Radiographs in various diameters and positions were taken by means of a Berg spot-film frame, the exposures being from one-tenth to five-tenths of a second.

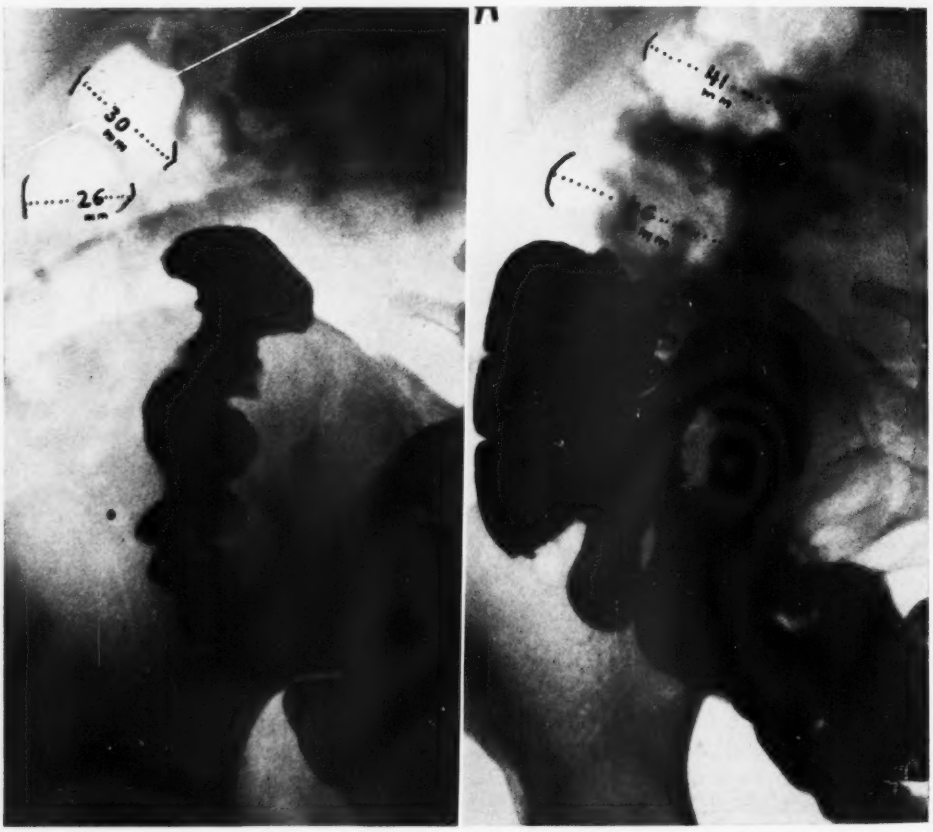
OBSERVATIONS

(*A*) *Terminal Ileum.*—In the upright position, the terminal loop of the ileum ascends diagonally and turns almost laterally in slender persons, but more forward

[1] Dr. A. E. Barclay (RADIOLOGY, 1933, 170–176, August, 1939) and the author wrote their papers simultaneously, submitting them within a week of the same time.

in those with large abdomen or flabby abdominal muscles; for the position of the cecum varies according to the shape and depth of the abdominal cavity (Fig. 11).

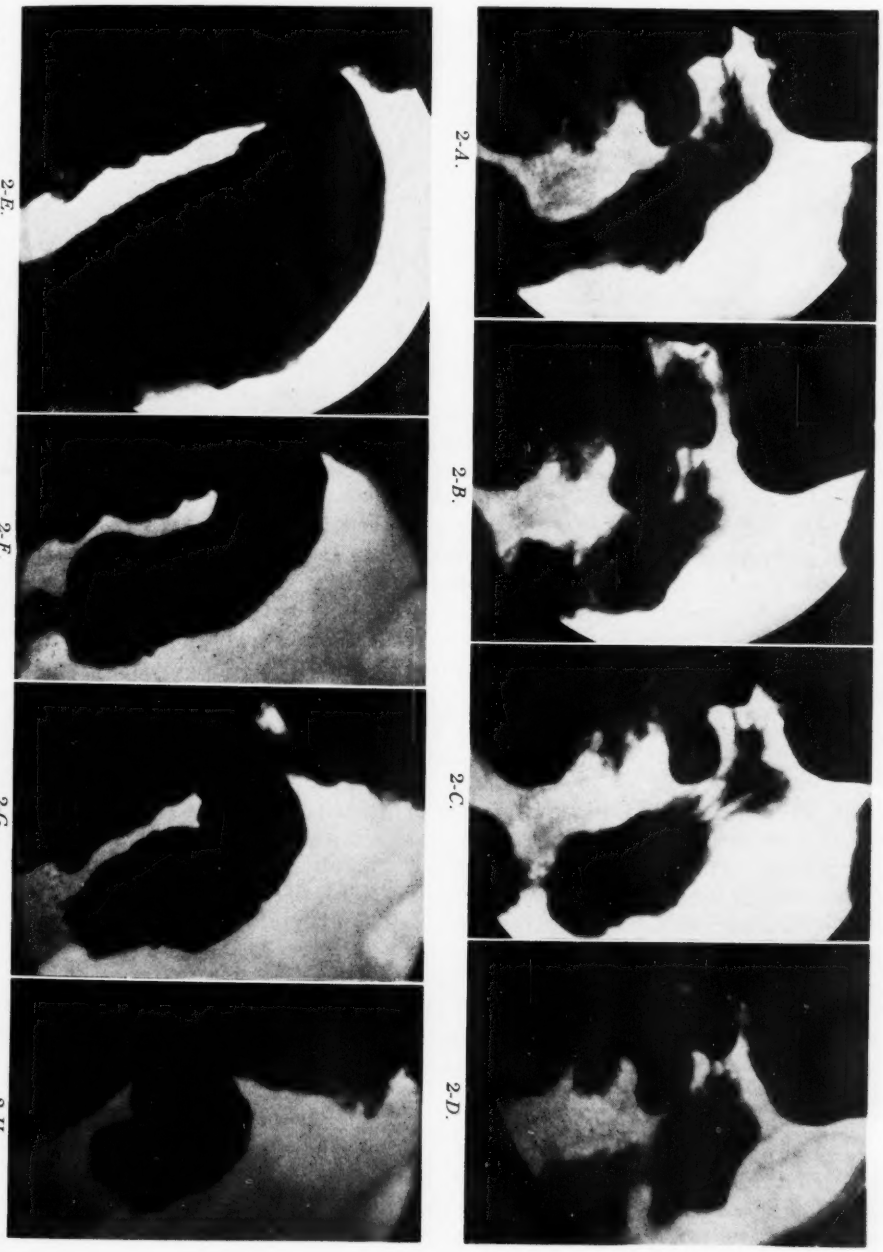
The time at which the terminal ileum begins to fill is extraordinarily variable. In healthy persons, opaque food may reach the ileocecal valve as early as 35 minutes after oral ingestion; in others, an interval of four or five hours is normal. It is evident that the beginning of the filling of the terminal ileum depends on the beginning of gastric evacuation, while the completion of the passage through the ileum depends on the termination of gastric evacuation and on the rate of passage through the ileocecal valve. In other words, the time it takes for the barium to pass through the terminal ileum is proportional to the rate of gastric evacuation, provided the ileocecal valve is normal. If, for instance, the pylorus relaxes early and frequently, but gastric evacuation is slow, the barium will reach the ileocecal valve soon, but the terminal ileum will remain filled for a long time. This form of ileal "stasis" is common, since common and variable factors may induce slow gastric evacuation; for example, the type of food taken after the opaque meal, or trivial emotional reactions. Furthermore, the rate of normal gastric evacuation depends largely on the



A *B*

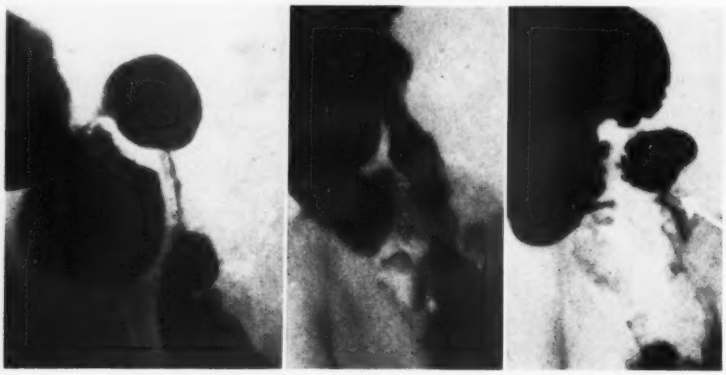
Figs. 1-*A* and 1-*B*. Four hours after an opaque meal the opaque medium has risen to the tip of the terminal ileum (1-*A*). Despite rhythmic peristalsis, the contents do not pass into the cecum. Twelve minutes later (1-*B*), the valve has relaxed. Note that in 1-*A* the lumen of the ascending colon, outlined by gas, is narrower than in 1-*B;* the lumen distad to the filling widens (receptive relaxation).

amount and kind of the opaque meal given, and since there is as yet no standard meal, the results of different observers cannot be compared. The use of a uniform meal, as was done in this series, eliminates this one variable factor, but it does not rule out the effects of the many compensatory mechanisms which in the digestive tract make up by delay in one section for accelerated passage in another, and *vice versa*. For instance, very rapid gastric evacuation does not necessarily cause the ileum to fill



Figs. 2-*A*, 2-*B*, 2-*C*, 2-*D*, 2-*E*, 2-*F*, 2-*G*, and 2-*H*. Upper row, 2-*A* through 2-*D*: Rhythmic peristalsis in terminal ileum, ileocecal valve closed; no barium enters the cecum. Lower row, 2-*E* through 2-*H*: After a sudden relaxation (2-*E*), the terminal ileum is emptied by one single stripping contraction (2-*F* through 2-*H*). Spot films taken at intervals of from seven to nine seconds. The two series show that food is moved on into the cecum by means of changes in tone, but not by rhythmic peristalsis.

early, as the duodenum or jejunum may retain the opaque medium; *vice versa*, slow gastric evacuation is often associated with rapid passage through intestines. Accordingly, the rate of gastric evacuation, though a dominating factor in the passage through the ileocecal region, is not the sole one to influence it. Generally speaking, the terminal ileum begins to fill about three hours after the beginning of gastric evacuation, and it is found to be empty seven hours after the stomach has emptied itself.



A *B*

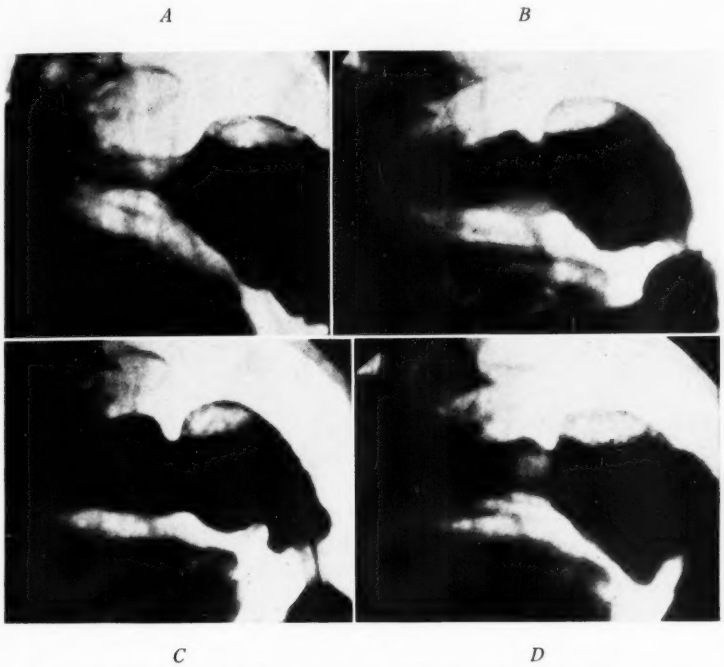
Figs. 3-*A* and 3-*B*. The terminal ileum is emptied by stripping contractions.

It takes from 15 to 60 minutes for the opaque medium to ascend from the lower ileal loops to the tip of the terminal one. How this initial filling is effected cannot be seen in normal cases in which the loop is invisible before barium enters it; but when, *e.g.*, in fermentative indigestion, the terminal loop is filled with gas, it appears distended before the opaque meal passes into it. During the period at which the terminal loop is entirely filled but barium has not yet passed through the ileocecal valve, there is in the terminal loop a succession of rhythmic peristaltic contractions which, following each other at from 4 to 6 cm. intervals, progress toward the ileocecal valve at about half the rate of the gastric waves, thus resembling a slow-motion picture of gastric peristalsis. At irregular intervals, the caudad motion is interrupted by pendulum movements. After a period of between 20 and 40 minutes, the entire activity ceases suddenly, thus making the terminal loop appear inert and widened. Usually, this atonic phase precedes by a few minutes a tonic contraction which begins about 12 cm. proximad to the ileocecal valve and "milks" the contents into the cecum, thereby evacuating completely the terminal loop within from 10 to 20 seconds. Normally, there is no other mechanism of evacuation. The wave-shaped peristalsis does not move the contents through the valve (Fig. 2). The tonic "milking" or "stripping" contractions occur at intervals of from three to 15 minutes approximately; they are followed by gradual refilling of the terminal ileum from proximad. Thus, at the period of active evacuation, the terminal loop may be free of barium for a number of minutes.

At the sites of contractions, longitudinal rugæ become visible; in the relaxed portions, filling is too massive to show the mucosal relief, even under compression. When most of the opaque medium has been driven into the cecum, there may remain in the terminal ileum a residue which may coat the mucosal relief; it then resembles that of the duodenum (6). When the

valve is closed, the rugæ of the ileum proximad to it converge (Fig. 4).

The shadow of the opaque medium in the terminal ileum is very homogeneous; normally, there are neither gas bubbles nor the small granular defects caused by mucus.

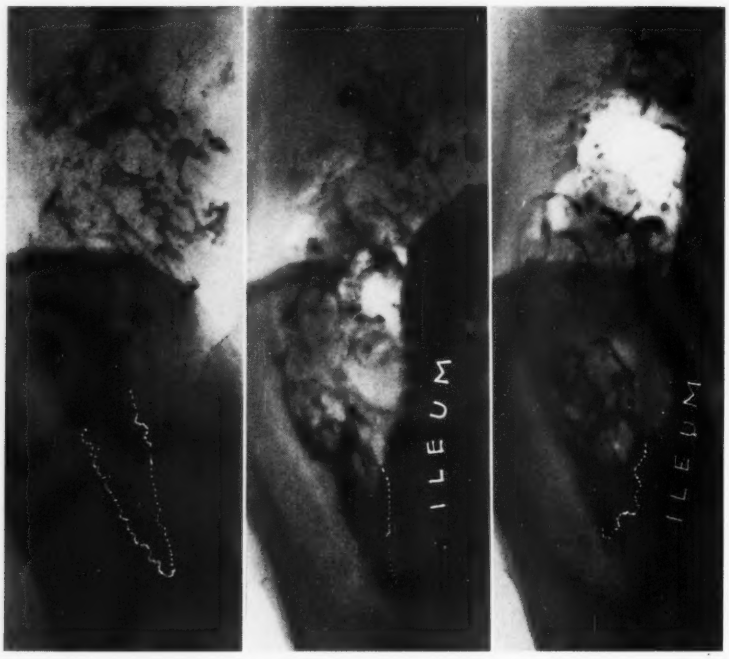


Figs. 4-*A*, 4-*B*, 4-*C*, and 4-*D*. Passage through the ileocecal valve; intervals of seven seconds. Valve closed (4-*A*), terminal ileum to it is funnel-shaped and shows convergent mucosal folds. The valve begins to relax (4-*B*) while a stripping contraction in the ileum sets in. Valve entirely open (4-*C*), opaque food passes through it. Valve begins to close (4-*D*). No changes in the position of the terminal ileum (see text).

(*B*) *Cecum.*—In the upright position, the cecum is in contact with the anterior wall of the abdomen. Even in cases in which the ascending colon or hepatic flexure turn strongly backward, the cecum lies anteriorly, as shown by lateral views (Fig. 11). Very commonly its course is not straight, but tortuous or almost semicircular (Fig. 12). The position of the lower pole of the cecum is subject to distinct physiologic changes, to be discussed hereafter.

When entering the cecum, the opaque medium slides down passively. This is due to a "receptive relaxation," as studied by the following method. A small amount of opaque fluid, about 300 c.c., is injected by enema; then, by rotation, changes in position, and manipulations, the medium is distributed all over the colon. When the cecum is filled, the largest amount of opaque fluid possible is evacuated by aspiration or spontaneously, or in both ways. The remaining opaque fluid coats the mucosa of the collapsed colon. Lumen and relief of the empty colon do not change during indefinite periods of observation. Filling of the stomach does not alter the appearances. But, when opaque food reaches the loops proximad to the terminal ileum, the cecum widens in lumen, ob-

viously by loss of tone (Fig. 5). While the cecum fills, a widening of the lumen precedes the opaque shadow by from three finally the entire opaque medium has been passed into the cecum and the ileum is empty, an exceedingly gentle and gradual



A *B* *C*

Figs. 5-*A*, 5-*B*, and 5-*C*. Receptive relaxation of cecum and colon. The colonic mucosa had been coated with barium. Lumen very narrow two hours after opaque meal (5-*A*). Slight widening (5-*B*) when food reaches the upper ileum. Definite widening (5-*C*) when food has reached the lower ileum. Compare with Figures 1-*A* and 1-*B*.

to five cm.; the relaxed portion is usually filled with gas (Fig. 1). The widened area can be seen moving upward gradually along the ascending colon, distad to the rising barium column. When an amount about the size of an egg has been driven into the cecum, shallow waves travel along the lower cecal pole in either direction at very low speed; they produce the slight curves that are normally seen in the cecal contour. With the progress of filling, these peristaltic waves increase in both rate and depth. The increase of filling causes the cecum to expand at first in length and width; this may lead to a descent of the lower pole of the cecum into the pelvic cavity, sliding along the anterior wall of the abdomen. When change in width and length sets in. Quite slowly, in the course of from six to ten hours, the cecum and ascending colon narrow in lumen to about two-thirds the previous width, and the lower pole of the cecum re-ascends, while barium is moved on into the transverse colon. Commonly, the cecum is found at 24 hours to stand about 10 cm. higher than at seven hours (Fig. 9). There are marked individual differences in this respect. For instance, when the cecum is congenitally short, it does not, as a rule, expand definitely downward, and its position then remains unchanged throughout the passage of the opaque meal through it. In other persons the cecum is congenitally low, and may

remain so; but this is not very common. Simultaneously with changes in the position of the cecum, peristalsis alters its profile (Fig. 4). In front of it, the terminal ileum ends in a funnel-shaped positive shadow protruding between the lips, the

A *B* *C*

Figs. 6-*A*, 6-*B*, and 6-*C*. A stripping contraction has just emptied the terminal ileum (6-*A*). Two minutes (6-*B*), rhythmic peristalsis sets in; four minutes later (6-*C*), increase in tone drives the barium upward.

appearance. Haustra form in both cecum and ascending colon; in the former, they are irregular in size and shape, and may amount to pseudodiverticula of continually changing configuration. In the ascending colon, they are much more regular and almost uniform; these haustra travel upward at a speed of about 0.5 cm. in 10 minutes (Fig. 12), while new haustra form simultaneously cephalad to those which move on (Fig. 12). After a number of hours, when the barium reaches the splenic flexure, activity slows down.

The density of the opaque medium is almost homogeneous at the beginning of cecal filling, but a spongy appearance may result subsequently from small gas bubbles and mucus. As heretofore mentioned, a larger gas bubble is commonly seen above the upper level of the opaque medium.

The relief of the cecum is usually not visible.

(*C*) *Ileocecal Valve.*—The ileocecal valve, when closed, casts a negative shadow which resembles a pair of lips as seen in latter pointing into the cecal lumen. The valve is inserted in the mesial wall of the cecum in slender persons, but farther back in those with large abdomen, in whom the cecum lies farther forward.

Between the tip of the funnel produced by the terminal ileum and the actual lumen of the cecum there is an interval a few millimeters wide which indicates the true caliber of the valve. The funnel is outlined by a number of converging ileal rugæ.

When barium passes through the valve, its opening is seen as a rounded channel about 8 mm. wide (Fig. 4-*C*). After all of the barium driven through the valve has passed into the cecum, the funnel and the lips become again visible as before.

Detailed observations, supported in 38 cases by serial radiographs taken at variable intervals, show that normally the valve opens only while the ileum is being emptied by "stripping" tonic contractions, but remains closed during the intervals between them. The valve resists, as it were, the progress of such amounts of

barium as are formed and moved by rhythmic wave-shaped peristalsis of the ileum. It could not be ascertained whether the flow back from the cecum into the ileum, even when the opaque medium was very liquid, *e.g.*, in spontaneous diarrhea or

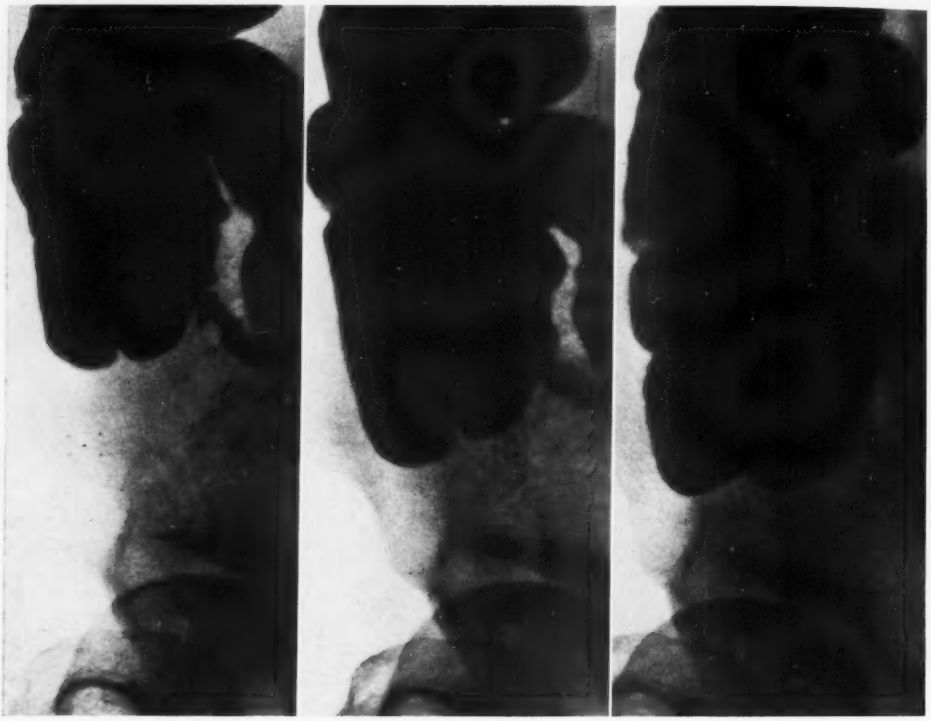


Fig. 7. *A* *B*

Figs. 7, 7-*A*, and 7-*B*. Physiologic descent of cecum. Six hours after opaque meal; 22-minute intervals. Upright position, four foot anode–film distance; no change in position of patient, tube, or film.

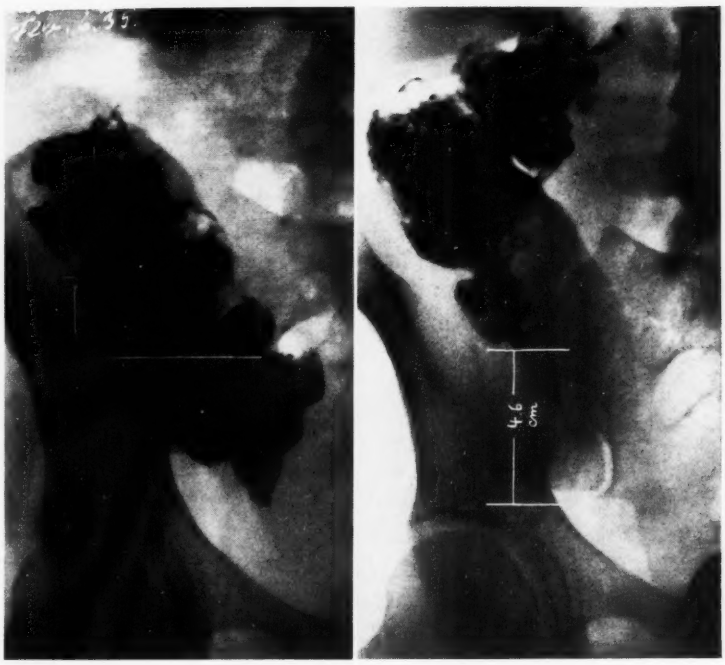
passage through the valve is the result of active relaxation, or merely of yielding to the greater pressure exerted upon the ileal contents by the "stripping" rushes. Our observations do not agree with the view that the valve is closed while the terminal ileum is straightened and in contact with the cecum, but opens while the distad end of the terminal ileum is hooked upward by peristalsis (10). Even when the ileum is permanently displaced upward, *e.g.*, by adhesions, the valve closes normally.

In physiologic conditions, the valve is competent. Except in the case of profound anatomical alterations, the author has not seen barium given by the mouth to under the action of purgatives. The results of enema examinations, of course, have no bearing upon this question, because the conditions then are not physiologic.

Experiments on the control of the ileocecal valve by influences arising in other organs are reported in a separate paper.

(*D*) *Cecocolonic Sphincter.*—The cecocolonic sphincter is recognizable by the persistent narrowing it causes while contracted. It is usually located just above, distad, to the ileocecal valve. The sphincter obviously is not permanently contracted: while the barium gradually fills the ascending colon, it is usually not vis-

ible, but when, afterward, colonic-mass peristalsis sets in, it contracts strongly, thereby retaining the opaque medium and the author suspects that the type of food taken before the examination has something to do with this variability.



A *B*

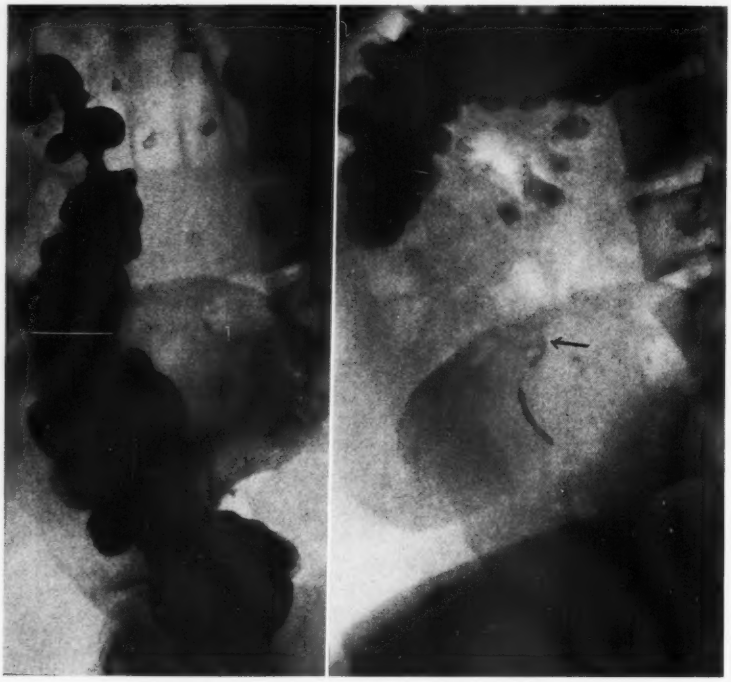
Figs. 8-*A* and 8-*B*. Physiologic ascent of cecum. Cecum seven hours (8-*A*), and 26 hours (8-*B*) after opaque meal; no bowel movement during the interval. Upright position, six foot distance, Lysholm grid, position identical on both exposures.

present in the cecum, and separating it from the contents of the colon that are driven off by mass peristalsis. The barium retained in the cecum commonly remains there until 24 hours later. In other words, retention of barium in the cecum after evacuation of the colon is physiologic.

There appears to be an interrelation between the hepatic flexure and the cecocolonic sphincter: when the former is well angulated, mass movement commonly contracts only the transverse portion and barium is retained in the entire ascending colon beside the cecum. In these cases, the cecocolonic sphincter may fail to be visible. But these mechanisms are interchangeable even in the selfsame person,

(*E*) *Appendix.*—Since the appendix of healthy persons may have been previously affected by some slight or repeated inflammation, it is very difficult to say exactly what is normal, for residues of inflammation may interfere with the normal mechanics of so small an organ. It is rather by knowing the pathologic appearances that the normal standard can be determined. Anyway, in persons not conscious of abdominal trouble, the appendix fills either entirely or partially within two hours after barium first enters the cecum, sometimes even immediately after the first portion has passed through the ileocecal valve. The rate of filling depends on the activity of the cecum; if peristalsis and tone are in-

creased, *e.g.*, after administration of certain purgatives, the appendix usually fills earlier and more completely than was observed by the activity of the mucosa. The density of the barium shadow of a normal appendix is entirely homogeneous.



A *B*

Figs. 9-*A* and 9-*B*. Physiologic ascent of long cecum. Seven hours (9-*A*), and 24 hours (9-*B*) after opaque meal. Upright position, right oblique, four foot distance. The white line in 9-*A* shows the position of the cecum as traced from 9-*B*, where the appendix indicates it.

on a previous occasion (Fig. 13). After having filled, the appendix does not show peristalsis, but slight movements may result from changes in the position of the cecum. Emptying of the appendix, on the other hand, is a distinctly intrinsic mechanism. After a variable period of inactivity, peristaltic waves travel along the appendix without emptying it. Then, about four or five hours after completion of the filling, the appendix is emptied suddenly by a tonic contraction which both narrows and shortens the lumen.[2] A streak of barium may remain in the appendix and then disappear after a few hours, possibly

In numerous observations and 187 experiments in man, made with castor oil, magnesium sulphate, pituitrine, and physostigmine or its derivates, it was found that no form of colonic activity, including mass peristalsis, induces emptying of the appendix. Sometimes, however, the appendix is emptied during the operation of a cleansing enema.

A normal appendix is empty before the cecum empties itself. As a rule, constipation does not prevent normal emptying of the appendix.

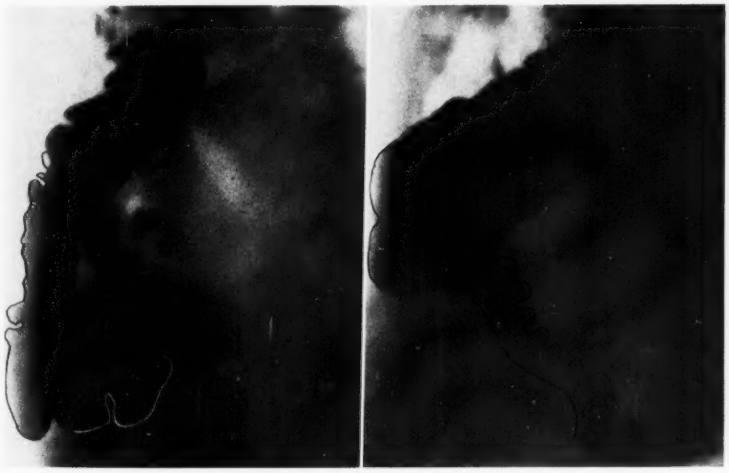
MECHANICS OF THE ILEOCECAL REGION

The observations indicate that the transport of food through the ileocecal region

[2] Pathologic contents may induce evacuation by increased rhythmic peristalsis, *e.g.*, gas or fecaliths may be moved on by annular contractions.

A *B* *C*

Figs. 10-*A*, 10-*B*, and 10-*C*. Descent and re-ascent of cecum. 10-*A*, six hours; 10-*B*, nine hours, and 10-*C*, 23 hours after opaque meal. Contours redrawn. Upright position, six foot distance. The white lines indicate the positions as traced from the preceding radiographs.



A *B*

Figs. 11-*A* and 11-*B*. Position of the cecum in a slender person (11-*A*), and in a stout person (11-*B*). Upright position, lateral view, four foot distance.

(that is, against gravity and through sphincters of variable strength), is effected chiefly by variations in tone. In the terminal ileum, where these are rapid, ini-

Figs. 12-*A*, 12-*B*, 12-*C*, and 12-*D*. Passage through cecum. Recumbent position, left side elevated by 45°, intervals of 25 minutes, beginning six hours after opaque meal. Position of tube, film, and patient unchanged throughout the period of observation. Beginning haustration (12-*A*); filling increases (12-*B*), cecum widens and descends. Ileum almost empty (12-*C*), haustration increases. By increase in tone (12-*D*), the cecum ascends, and the contents are gently pushed upward. Note the continuous formation of new haustra and the caudad progression of those that are filled.

tial relaxation due to loss of tone is followed by a sudden tonic contraction which drives the food into the cecum. These "stripping" movements resemble in character and rate the mass peristalsis of the transverse colon, and have a similar mechanical effect. In the cecum and ascending colon, initial relaxation with subsequent contraction occurs at a very much lower speed. After a "receptive relaxation," gradual increase in tone raises the cecum and narrows the lumen of the entire ascending colon in the course of many hours. During this time, the opaque food is caught, as it were, by the horizontal septa that the haustra form in the lumen of the ascending colon. The continuous cephalo-caudad progression of these haustra helps to carry the contents upward in very much the same way as a dredging machine. In both ileum and colon, rhythmic wave-shaped peristalsis does not accomplish actual transport of the opaque food. This peristalsis, together with pendulum movements, seems to mix the contents rather than to move them on. This is quite evident in the ileum, where peristaltic waves reach the valve without driving any opaque medium through it; it can also be observed in the cecum, where this peristalsis is much slower.

The ileocecal valve is passable when the food is driven forward by the tonic contractions of the terminal ileum. Whether this is due to active relaxation of the valve or to a merely passive yielding, could not be ascertained: in other words, it is not verifiable roentgenologically whether the ileocecal valve acts exclusively as a valve, or temporarily like a sphincter.

The cecocolonic sphincter contracts strongly while the ascending portion distad to it is evacuated by colonic mass peristalsis; the sphincter is one of the normal *points d'appui* (4) of mass movement. Contraction of the sphincter during this movement causes food to be retained in the cecum. This is a physiologic cecal stasis. Occasionally the sphincter may alternate with the hepatic flexure in this respect.

The appendix is filled passively by cecal peristalsis, but it empties itself by tonic

A *B*

Figs. 13-*A* and 13-*B*. The effects of castor oil. The colon eight hours after barium meal (13-*A*). Examination repeated, one teaspoonful of castor oil having been given with the barium (13-*B*): radiograph taken eight hours later. Note differences in width and position. Inserts: the appendix, invisible in 13-*A*, is distinctly seen in 13-*B*, where it points straight upward behind the cecum.

contractions of the appendicular muscles. This evacuation is entirely independent of any form of colonic activity; it is an intrinsic appendicular mechanism essential to the integrity of the organ.

A *B*

Figs. 14-*A* and 14-*B*. Spot films of the appendix, taken at 11-minute intervals. In 14-*B* the appendix has become short and narrow, owing to a tonic contraction which emptied most of its contents into the cecum.

With many individual and accidental variations, these physiologic mechanisms re-appear in every normal digestive tract. Occasionally, when tonic contractions are either impaired or deficient, rhythmic peristalsis may help to propel the food: this is another example of "stand-by" mechanisms to be added to those discussed by Barclay (4). But, as previously shown for the colon and esophagus (16, 18), absence or deficiency of tonic relaxations and contractions is distinctly abnormal, though not necessarily indicative of actual disease.

The aforementioned observations would seem to confirm the notion gained from previous studies, that "diastolic" and "systolic" changes of intestinal tone are essential to the caudad motion of food through the bowel. The fact that these tonic changes are frequent and rapid in the esophagus, less frequent and slower in the terminal ileum, and very gradual in the colon, is in accord with Alvarez' gradient theory. This gradient, however, is interrupted, as it were, by the sudden and powerful mass movements in the transverse and pelvic colon.

SUMMARY

1. Both in the terminal ileum and in the cecum and ascending colon, opaque food is moved on chiefly by "systolic" tonic contractions which are preceded by "diastolic" relaxations due to loss of tone. The tonic variations are fairly rapid in the terminal ileum, but very slow in the ascending colon; in the latter, the caudad progression of the haustra helps to carry the food upward as though by a dredging device.

2. Rhythmic peristalsis does not move on the contents appreciably, unless it occurs as a stand-by mechanism.

3. A "receptive relaxation" of the cecum begins as soon as opaque food reaches the ileal loops proximad to the terminal loop.

4. The cecum is normally low in position when it begins to fill, and rises while the contents are moved on into the transverse colon.

5. The ileocecal valve remains closed while peristalsis in the terminal ileum is wave-shaped and rhythmic; it becomes passable when the opaque medium is driven forward by tonic "stripping" contractions in the terminal ileum. The valve is normally competent for opaque food given by the mouth.

6. The cecocolonic sphincter is relaxed while the ascending colon fills, but contracts strongly while mass peristalsis drives the contents into distal parts. This contraction causes a physiologic stasis in the cecum.

7. The vermiform appendix is filled by the peristalsis of the cecum, but is emptied by its own intrinsic tonic contractions.

REFERENCES

(1) ADRIAN, E. D.: The Mechanism of Nervous Action. University of Pennsylvania Press, Philadelphia, 1932.

(2) ALVAREZ, W. C.: The Mechanics of the Digestive Tract. New York, 1928.

(3) ALVAREZ, W. C., and TAYLOR, F. B.: Changes in Rhythmicity, Irritability, and Tone in the Purged Bowel. Jour. Pharm. and Exper. Ther., **10,** 365–377, 1917.

(4) BARCLAY, ALFRED E.: The Digestive Tract Cambridge University Press, London, 1936.

(5) Idem: The Practical Importance of Mechanics in Digestion. Am. Jour. Roentgenol. and Rad. Ther., **40,** 325–334, September, 1938.

(6) BECKER, R., and OPPENHEIMER, A.: Normale und pathologische Funktionen der Verdauungsorgane im Röntgenbild. Thieme, Leipzig, 1931.

(7) CASE, J. T.: X-ray Studies of the Ileocecal Region and the Appendix. Am. Quarterly Roentgenol., **4,** 77–83, 1912.

(8) Idem: Roentgenologic Observations of the Function of the Ileocolic Valve, with Special Reference to the Causation of Ileal Stasis. Jour. Am. Med. Assn., **63,** 1194–1199, 1914.

(9) HIRSCH, I. S.: Cecocolic Sphincteric Tract. Med. Jour. and Record, **119,** 541–549, June 4, 1924.

(10) HUNTER, R. H.: The Ileocecal Junction. Jour. Anat., **68,** 264–269, January, 1934.

(11) HURST, A. F.: The Ileocecal Sphincter. Jour. Physiol., **47,** 54–56, 1913.

(12) Idem: The Sensibility of the Alimentary Canal. London, 1911.

(13) Idem: The Unhappy Colon. Lancet, **1,** 1483–1487, June 29, 1935.

(14) KANTOR, J. L.: The Low Cecum. Am. Jour. Roentgenol. and Rad. Ther., **14,** 207–215, 1925.

(15) Idem: Anomalies of the Colon: Their Roentgen Diagnosis and Clinical Significance. RADIOLOGY, **23,** 651–662, December, 1934.

(16) OPPENHEIMER, A.: Esophageal Varices. Am. Jour. Roentgenol. and Rad. Ther., **38,** 403–414, September, 1937.

(17) Idem: Beobachtungen an der Ileocecalregion. Röntgenpraxis, **3,** 1099–1101, 1931.

(18) Idem: Physiologie der Dickdarmmotorik. Klin. Wschnschr., **10,** 201–204, Jan. 31, 1931; and Pathologische Dickdarmbewegungen. Klin. Wschnschr., **10,** 930, 931, May 16, 1931.

(19) ORNDOFF, B. H.: Roentgen-ray Studies of the Appendix, Cecum, and Ascending Colon. Jour Am. Med. Assn., **87,** 1294–1297, 1926.

RADIUM PROTECTION: MEASUREMENTS OF EXPOSURE TO GAMMA RAYS[1]

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NEED for protection against roentgen rays was not realized until the many tragic fatalities among the pioneers in roentgenology shocked the medical profession into positive action. Co-operative efforts of radiologists, physicists, and designers of x-ray equipment produced safety measures which are effective when enforced.

Protection from the more penetrating rays emitted by radium has evolved more slowly. From the days of the Becquerel burn, in 1901, the need for caution was apparent. The gamma rays of radium are far more penetrating than the roentgen rays ordinarily used in therapy or diagnosis. There are a few 1,000,000-volt machines now functioning in this country, and they produce rays comparable to the softer gamma rays; to equal the hard gamma rays, from 2,000,000 to 3,000,000 volts would be necessary.

Hence, protection in radium work is a more difficult problem than in roentgen therapy or diagnosis. The innocent appearance of the small platinum or brass or gold cartridges containing the powerful element so widely used in the war against cancer is very deceptive. As Failla (1) has pointed out, some gamma rays are able to penetrate 25 cm. of solid lead. With the reawakened interest of the medical profession in cancer therapy, large amounts of radium are imported annually. A recent editorial in the *Journal of the American Medical Association* (2) reported that the largest importation of radium for medical use in all these recent years of large purchases had been in 1938. Many hospitals throughout the country are now obtaining sizable amounts of radium for therapeutic purposes.

Any definite aids or short cuts to protection are hence of practical value. There are two classes of hospitals or clinics to be considered. The large radium centers, possessing several grams of the element and devoted mainly to cancer therapy, have very adequate protection. With the aid of skilled physicists, provisions for ample lead screening, ventilation, distance, and rotation of personnel have been worked out with great care. However, the small hospital or clinic with lesser amounts of radium in more occasional use, or the individual physician who owns or rents small amounts of radium, especially needs help in regard to protection. Often there is no physicist associated with these smaller clinics, and no expensive measuring equipment (needing frequent calibration and adjustment) is owned by them.

The various national radiologic societies combined some years ago with the United States Bureau of Standards (which measures practically all the radium sold in this country) to form a Committee on Protection. This Committee endeavors to correlate the physical and biologic effects of irradiation, and issues a handbook on Protection—the best guide we have on this subject. The last handbook was reprinted in the October, 1938, issue of the Journal of this Society (3).

Precise biologic effects, however, vary with the individual and are not clear cut. Effects of gamma irradiation on the general health of the individual, on his blood-forming organs and reproductive system, have to be further evaluated.

General physical examinations and monthly blood counts of all workers with radium are stressed in this handbook. However, the practical value of the blood

[1] Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

counts is questionable. As the Committee points out, blood counts vary with the individual, with the time of day, with digestion, with exercise, and with the technic of the hematologist. Probably with our present hematologic methods, definite changes in the differential blood count indicate serious late effects of over-exposure, just as descriptions in medical textbooks of malignant lesions portray usually quite advanced stages of disease.

An extremely important finding of the Committee was that apparently a general exposure of 0.1 r per day of gamma irradiation has been tolerated in the past by workers over many years without any obvious impairment of health. This gives us a definite physical basis of measurement.

Equipment to measure gamma radiation in roentgen units or fractions of roentgen units is expensive, needs periodic adjustment, and requires the services of a trained physicist. If these measurements could be once made and correlated with a simple photographic method of measuring exposure, we should have a practical guide to guard against over-exposure.

In 1922, following the report of the death of five radiologists of aplastic anemia, obviously due to over-exposure to irradiation, Pfahler (4) conducted a survey on the subject of adequate protection. Several hundred radiologists throughout the United States filled in and returned questionnaires which included their complete blood counts, results of physical examinations, and dental films worn for two weeks. In his excellent paper Pfahler evaluated the findings and developed and checked the darkening on the dental films according to fractions of erythema skin doses on his own moderate voltage machine (9-inch spark gap). He decided that any film which after two weeks shows a definite blackening connotes insufficient protection. His article contained references to most of the literature on protection up to that date.

In 1926, Quimby (5), working with radium, placed the film method of estimating exposure to gamma rays on a more quantitative basis. She stressed comparison of test films with films exposed to known quantities of radiation. The density of the exposed films was measured by means of a photo-electric photometer. The densities were calibrated with the erythema skin dose obtained by tests of irradiation on the skin of patients. She found that 0.0025 of a skin erythema dose produced perceptible darkening of the film, and she made ten standard films, ranging from 0.005 to 0.015 of an erythema skin dose.

In 1931, Failla read a paper on radium protection before this Society. He reviewed the subject thoroughly and referred to Quimby's work. He calibrated exposures in terms of threshold erythema doses, and found that technicians working over many years with exposures of approximately 0.001 threshold erythema dose per month showed no apparent injury. He brought out the very important point that in working with films the quality of the radiation tested must agree with that of the standard; for instance, there is a significant difference in the photographic effect of low voltage and high voltage roentgen rays, and of gamma rays. We found this true in our own work.

Our own work has been done with radium, endeavoring to determine safe limits of exposure with our 2 gm. in use at The Mayo Clinic. We have tested the different treatment rooms and operating rooms in the radium therapy department with ionization chamber methods and with photographic films.

Equipment.—In order to measure exposure quantitatively in terms of roentgens, it was necessary to test the accuracy of the ionization chamber in measuring gamma radiation and to expose film to known numbers of roentgens for comparison. The problem of the determination of gamma radiation in roentgens has not been satisfactorily settled as yet, but the value 8.4 r per hour per milligram at a distance of 1 cm. from a point source filtered by 0.5 mm. Pt would appear from the literature to be at least approximately correct.

This value has been assumed to be correct for this work.

The tube of radium used throughout these experiments as a standard contained 10.15 mg. of radium and had a filtration of 6.75 mm. of brass. It was assumed that this filtration was equivalent to 2.25 mm. of Pt and that the absorption coefficient of Pt is 0.2 per millimeter (6). With the further assumption that the tube is a point source, the intensity of radiation at a distance of 1 cm. would be 60 r per hour, and the intensity at greater distances can be computed from the inverse square law. This value may be in error by several per cent, but it is considered to be sufficiently accurate for the purposes of this investigation since an error of 15 or 20 per cent is not of particular importance in measuring the quantity of radiation to which one is exposed in a radiologic department.

TABLE I

Comparison of the Quantity of Radiation Calculated and Measured by the Victoreen r-meter

Distance, cm.	Time, hours	Quantity in Roentgens		Percentage of Calculated
		Calculated	Measured	
		25 r Chamber		
15	54.0	14.4	15.6	108
5	5.4	13.0	12.5	96
5	8.0	19.2	17.3	90
10	10.5	6.3	6.2	98
10	24.5	14.7	14.1	96
			Average	97.6
		0.25 r Chamber		
120	54.0	0.225	0.232	103
30	3.0	0.200	0.182	91
60	10.6	0.177	0.169	95
60	10.5	0.175	0.166	95
90	24.5	0.182	0.181	99
			Average	96.6

The ionization system used in this work was a Victoreen condenser r-meter with a 0.25 r and a 25 r chamber. For the weak intensities to be measured, the 25 r chamber would require too long a period of exposure to be practical; hence, the 0.25 r chamber was used for the actual measurements at various places in the department. Table I gives a sample of measurements made at several distances from the standard tube of radium for various periods of time with each chamber. The agreement between the calculated and measured quantities, while differing by as much as 10 per cent, is considered quite satisfactory, in view of the distances involved, the size of the chambers, the time of exposure, and such variable factors as leak, temperature, and barometer readings; and it was concluded that the 0.25 r chamber should give results of sufficient accuracy for the measurement of intensity at various points in the laboratory.

The film used was ordinary, small dental film obtained from the dental section, developed in the usual manner. The densities of the film were determined with a photo-electic cell photometer using an unexposed processed film for the zero density reading.

Variation of Film Density with Quality of Radiation.—The measurement of roentgen radiation at voltages less than 200 kilovolts in terms of roentgens is on a fairly sound basis, much more so than for gamma radiation. This might tempt one to determine exposure to gamma radiation by comparing the densities of test films with densities of film exposed to known quantities of roentgen rays. However, it is known that the photographic effect is a function, not only of the quantity but also of the quality of radiation. The effect of the quality of radiation on the density of film was investigated by exposing film to known quantities of roentgen rays of two qualities, 80 kilovolt peak with no filter and 200 kilovolt peak with 2 mm. of copper filter, and to gamma rays. The results of these tests are shown in Figures 1, 2, and 3.

Figure 1 is a reproduction of film exposed to 0.5, 1, and 2 r of each of the three qualities of radiation. That the density produced by the same quantity of radiation does depend significantly on the quality of radiation is immediately evident. Half a roentgen of the 80 kilovolt roentgen radiation produces a very pronounced darkening of the film, while four times this quantity, or 2 r, of gamma radiation produces only a slight darkening of the film. During exposure, each of these films had one corner covered with a cent. For the 80 kilovolt radiation,

the cent absorbed nearly all the radiation, leaving a spot, the density of which was very nearly zero. For the 200 kilovolt radiation the part of the film covered by the cent had a density very nearly corresponding to the density produced by half the quantity of radiation to which the film was exposed. For the gamma radiation the density under the cent corresponded to about 85 per cent of the quantity of radiation to which the rest of the film was exposed; on the film exposed to 0.5 r the shadow of the cent could barely be distinguished, but as the quantity of radiation to which the film had been exposed was increased, the shadow of the cent became more pronounced.

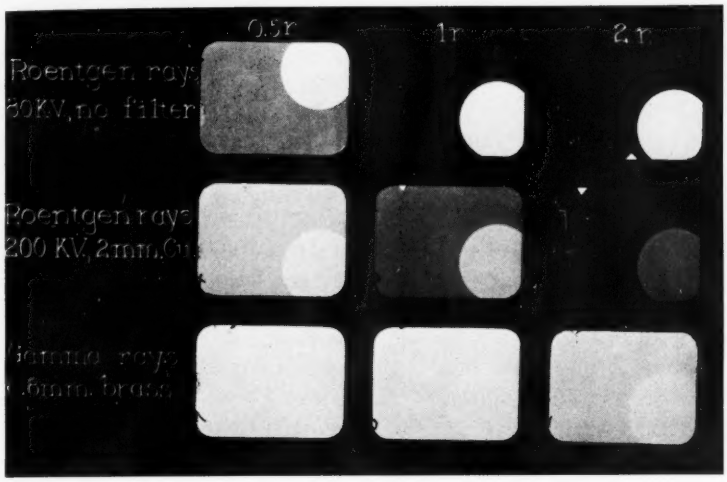

Fig. 1. Dental films exposed to the same quantities of two qualities of roentgen rays and to gamma rays. Shadow of cent in right hand corner.

In Figure 2 are shown three films of about the same density, one exposed to 0.5 r of the 80 kilovolt roentgen radiation, one to 1 r of 200 kilovolt roentgen radiation, and one to 4 r of gamma radiation (no cents on these films).

Figure 3 shows graphically the relation between quantity of radiation and density of the film for the three qualities of radiation for one set of film. The exact density for a given quantity of radiation depends somewhat on the film itself and the processing of the film, but the ratios of the densities for equal quantities of the three qualities of radiation were essentially the same for all the sets of film. The broken lines on the curves show the quantities of gamma radiation necessary to produce the same density as is produced by 0.5 r and 1 r of the two qualities of roentgen radiation, and, therefore, the error which would be produced in determining exposure to

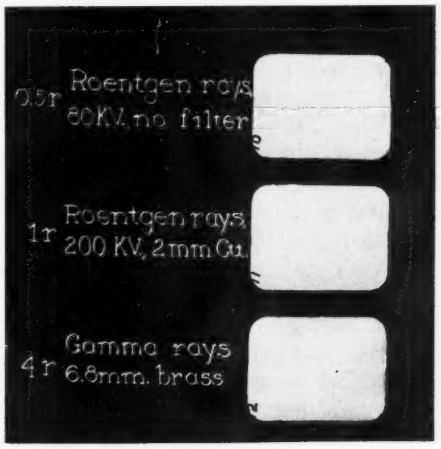

Fig. 2. Dental films exposed to such quantities of two qualities of roentgen rays and gamma rays as to produce approximately the same densities.

gamma radiation by comparing the densities of the test film to the densities produced by known quantities of either quality of roentgen radiation. From the standpoint of equal densities, it is seen that 3.6 r of gamma radiation is equivalent to 0.5 r of the 80 kilovolt radiation, a ratio of 7.2 : 1; 6.55 r of gamma radiation is equivalent to 1 r of the 80 kilovolt radiation, a ratio of 6.55 : 1; 2.2 r and 4.1 r of gamma radiation are equivalent, respectively, to 0.5 and 1 r of the 200 kilovolt radiation, ratios of 4.4 and 4.1.

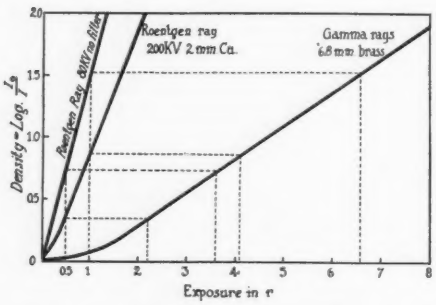

Fig. 3. Density curves for dental film exposed to roentgen rays of two different qualities and to gamma rays.

Comparison of the Ionization and Film Methods.—The use of the 0.25 r Victoreen chamber to measure small quantities of radiation is, in some respects, more convenient than the use of film. The ionization chamber is direct reading and since the maximum reading of the chamber is 0.25 r, it requires an exposure of only about one working day for intensities in the neighborhood of the tolerance dose. Its chief disadvantage is its size, which makes it unsuitable to carry, and thus it is not satisfactory for directly measuring the dose which an individual receives while working.

The dental films are small and easily carried in one's pocket, and, therefore, are ideal for measuring directly the exposure one's body receives. But because quantities of less than 0.2 r or 0.3 r do not produce a measurable density, and preferably the quantity should be nearer 1 r for quantitative measurements, the film should be exposed to intensities of the order of the tolerance dose for a period of about a week. This longer exposure, as compared to that of the ionization method, is not necessarily a disadvantage, as it averages the exposure over a longer period of time, giving a better average value if the daily exposure varies considerably.

Covering a part of the film with a dense object and noting the shadow cast may tend to give erroneous results. It is not possible to have sufficient thickness of the material to protect the film completely and the decrease in intensity caused by the object may not produce enough difference in film density to be noticeable; this is particularly true if the density of the film is very low. It must also be remembered that the radiation may not strike the film at the same angle during the entire exposure, so that the shadow of the object on the film may not be sharp and hence may be harder to detect, particularly if the object is small. Some type of photometer to compare densities of test film and film exposed to known quantities of radiation should be used rather than simply looking for shadows of objects placed over part of the film.

There is probably little difference in the accuracy of the two methods. The ionization method is subject to errors due to the inaccuracy of the instrument itself, natural leak of the chamber, dependence of the chamber on quality of radiation, and variations in temperature and atmospheric pressure, none of which should produce an error of more than a few per cent. The film method is subject to errors due to variations in the film, variations introduced by the processing, variations due to radiation quality, and errors in comparison of densities; but none of these errors needs to be appreciable if the work is carefully done and the comparison of densities is made with film exposed to the same quality radiation.

The difficulty of meeting the latter requirement is probably the most likely source of error, for, as shown in Figure 3,

the density depends on the quality of radiation as much as or more than on quantity of radiation. The determination of the quality of radiation to which one is exposed is not easy. An individual during the course of a day's work may be exposed to gamma radiation while giving radium treatments, and to roentgen radiation of varying quality while doing fluoroscopic examinations and giving roentgen therapy. The only way such an individual can obtain a very accurate estimation by the photographic method of the dose of radiation he is receiving is to carry a different film for each type of work, leaving the other films in a place where they will receive no irradiation while not being carried, then to compare the density of each film with the density produced by known quantities of radiation of the same quality, and to add the exposures to the various qualities together.

Even with these precautions, the quality factor cannot be entirely ruled out, for part of the radiation to which one will be exposed will be scattered radiation which will be softer than the direct radiation and one cannot be sure that the comparison films have been exposed to the same quality. The use of a piece of metal over a part of the film, and a comparison of the ratios of the two densities on the film will help to indicate how nearly equal the qualities have been.

That essentially the same results can be obtained by either method is shown in Table II. The values for the ionization chamber are calculated from the average for three different tests; most of the tests lasted for a single eight-hour day, and the average of these values was then multiplied by 5.5 to obtain the number of roentgens per week. The films were left in position for a few days to three weeks, and the number of roentgens per week of 5.5 eight-hour days was calculated. Except for the application room, no account was taken of the fact that the films were exposed twenty-four hours a day because no radium was in the rooms except during working hours. Considering that the measurements were not made simultaneously, the results are in remarkably good agreement. The two values for the office

TABLE II

Quantity of Radiation in Various Rooms in the Radium Section as Determined with Victoreen 0.25 r Chamber and with Dental Film

Room	Roentgens per Week	
	Ion Chamber	Film
Office	0.0	0.2 (less than)
Treatment	0.2	0.4
Operating No. 1	0.2	0.2
Operating No. 2	0.6	0.5
Applicator room	1.3	1.2

may appear to differ, but the value from the film was indefinite since it indicated no measurable quantity and could be given only as less than 0.2 r. The value from the film was definitely greater than that for the ionization chamber for the treatment room. This difference is probably due to a considerable amount of radium left near the film for a short time; this might easily have happened, since the ionization chamber was much more conspicuous than the film, and there was a tendency to stay away from the chamber. The results for the other three rooms are essentially the same by each method.

Conclusions.—When properly done, exposure to radiation can be quantitatively measured by either the ionization or the photographic method. The accuracy for either method is probably not good as compared to the measurement of roentgen-ray intensities, but either method can be sufficiently accurate to indicate the value of, or need for, more protective devices. The ionization method, with equipment now readily available, is not convenient to carry on one's person, and films are desirable for use in determining actual individual exposures. The ionization chamber is quite satisfactory for determining intensities at various points in a room. In the use of the photographic method, particular attention must be paid to the exposing of comparison film to the same quality of radiation as that to which the test films are exposed, because of the marked dependence of density of the film on radiation quality. However, the photo-

graphic method is a short cut and is reliable when calibrated with the effect of known amounts of radiation of the same quality, and also indicates the cumulative effect of irradiation over a period of time.

REFERENCES

(1) FAILLA, G.: Radium Protection. RADIOLOGY, **19**, 12–21, July, 1932.
(2) Editorial: Importation of Radium. Jour. Am. Med. Assn., **112**, 2,069, May 20, 1939.
(3) Advisory Committee on X-ray and Radium Protection: Radium Protection. RADIOLOGY, **31**, 481–490, October, 1938.
(4) PFAHLER, G. E.: The Effects of X-rays and Radium on the Blood and General Health of Radiologists. Am. Jour. Roentgenol., **9**, 647–656, October, 1922.
(5) QUIMBY, EDITH H.: A Method for the Study of Scattered and Secondary Radiation in X-ray and Radium Laboratories. RADIOLOGY, **7**, 211–217, September, 1926.
(6) PATERSON, RALSTON, and PARKER, H. M.: A Dosage System for Gamma-ray Therapy. British Jour. Radiol., **7**, 592–632, October, 1934.

DISCUSSION

MRS. QUIMBY (New York City): Dr. Fricke's paper is extremely timely and practical, and I am sorry there are not more persons here to take advantage of the simple and straightforward method of measuring he has set forth.

There are four points I would like to mention in connection with what he has said, each of minor importance in comparison with that of the whole problem.

With regard to the value of periodic blood counts, Dr. Fricke has pointed out the variations which may take place. However, if blood counts are always made under circumstances as nearly as possible the same, they are of much greater value. Blood counts are done on our radium workers once a month; always at the same time of day—about ten or eleven o'clock in the morning during the working day—and always by the same technician. Even so, we get fluctuations in blood counts, and we expect them. However, if in two or three months, we find a trend downward, we know that it is time to do something. On a few occasions we have found this sort of trend and have been able, by sending the boy away for a vacation, to stop it immediately. He has come back to us after two weeks or a month with his blood count normal, and we have had no further trouble. So, we do not feel that a small change in blood count necessarily indicates a serious reaction.

Second, you all saw Dr. Taylor's charts in which he indicated the change in quality of radiation with scatter. It is the scattered radiation we are seeking protection from much more general y than primary radiation. Therefore, while it is true that the quality of the primary beam must be considered, the quality is not really as different in going from 200 kv. x-rays to gamma rays, for instance, as might appear on the face of it. If you remember, Dr. Taylor's figure for scattered radiation was from a million-volt beam down in the neighborhood of 300 kv.

Dr. Fricke's measurements, I presume—my own, I know—were made on direct radiation. They may have included some scatter from the table beneath, but they were not definitely measurements of scattered radiation. Therefore, we are exaggerating any difference which may exist between different voltages. This is not a bad thing to do. It is always safer to exaggerate in the direction of necessary protection.

I was interested to find that Dr. Fricke got a ratio of 4 to 1 between the effects of gamma rays and x-rays on the film, because that is exactly what we got some years ago when we made our extended study on 200 kv. x-rays, 700 kv. x-rays, and gamma rays. I looked up the figures to-day to be sure, and found that they agreed perfectly with his.

One more point which I consider a practical one: I have been telling people that as far as x-ray protection is concerned, if a film is not too dark to read print through, it indicates an exposure of considerably less than 1 r of 200 kv. radiation. If the film is left for a week in the location being tested, and is no darker than that, the protection is ample.

If gamma rays are only one-fourth as effective on the x-ray film, it then becomes necessary to make that allowance. So that, whereas in a week with 200 kv. x-rays

we can tolerate such a darkening of the film that we can just barely read print through it, we cannot tolerate more than that in a month with gamma rays.

That is just a practical way of making a quick check-up without making a series of test films. It is not recommended for any sort of accurate determination of exposure, but it is a fairly simple way of finding out whether or not you had better go ahead and do something more accurate.

I wish to recommend to all of you, consideration of this sort of study of protection for yourselves or your associates or assistants.

DR. R. R. NEWELL (San Francisco): I have just one question. I also share Dr. Fricke's prejudice in favor of the film method because it lets you measure what you are getting in your everyday life in the laboratory without making it under artificial circumstances.

Will you put the second slide on the screen again? [Slide projected.]

I am struck by the appearance of more shadow of this disk by the gamma rays than by the 200 kv. x-rays; that is, it seems to me that this has stopped as much of the radiation as it did of the 200 kv. x-rays. It seems unlikely if they are gamma rays. I am thinking that the blackening on the film may be due to the secondary corpuscular rays in the air, which are quite soft and would not be dangerous to the bone marrow because they would not get into the middle of the body.

DR. L. S. TAYLOR (Washington, D. C.): I would like to correct a couple of statements made by Dr. Fricke, if I may, inasmuch as I am supposed to watch the treasury of the United States.

It was through an error that those reprints were sold for five cents and some given away. The Bureau had a small supply from which they gave away reprints for a while. In the newer editions that have come out, the price has been increased to ten cents.

The government printing office will not accept stamps. They just use franks, and nobody has been able to figure out how much a frank is worth. Send a certified check for ten cents, a postal money order, two nickels, or a dime.

The latest edition of X-ray Protection is Handbook 20, which superseded Handbook 15. If you ask just for "The Handbook," you may get the old one by mistake. Also, the last Handbook for radium is No. 23. Unless you ask for Handbook 23, or the latest, you may get Handbook 18, which has been superseded.

DR. FRICKE (*closing*): Regarding this radium protection handbook, by the way, the October, 1938, issue of our own Journal (page 481) reprinted the entire contents of the handbook.

As to the density of the penny on the slide, that third vertical line on the slide represented twice the quantity of radiation represented by the second. Of course, there are possibilities for all sorts of errors to occur in using the metal over the film, because in such a procedure you get glancing radiation at different angles. We merely put it in for contrast.

CHOLECYSTOGRAPHY: OPTIMUM VOLTAGE[1]

TETRABROM- *versus* TETRAIODOPHENOLPHTHALEIN

By R. R. NEWELL, M.D., *and* ROWLAND BRIGGS, M.D., *San Francisco*

From Stanford University School of Medicine

GRAHAM'S (1) original success in visualization of the gall bladder was with tetrabromphenolphthalein. For a year this was used by several workers, given by vein and by mouth, but was soon replaced everywhere by tetraiodophenolphthalein. (Some of the early tetraiodo. preparations had been toxic.)

[1] Read by title before the Twenty-fourth Annual Meeting of the Radiological Society of North America, Dec. 2, 1938, where the illustrative films were shown in the Scientific Exhibit.

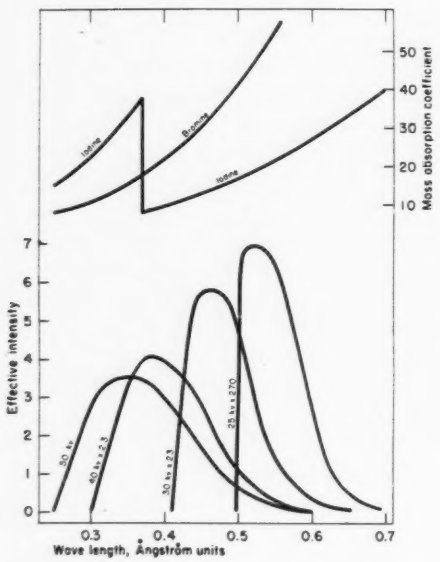

Fig. 1. The upper curves show relative absorption of bromine and iodine in equal concentration by weight for radiographic range of wave lengths.

The lower curves were calculated from Ulrey's continuous x-ray spectra from tungsten target at constant potentials 50, 40, 30, and 25 kv. These were multiplied by the transmission through 15 cm. of water; again multiplied by the absorption coefficient in tungsten (for relative action on the intensifying screen), and again multiplied by a factor so chosen as to make the areas under all four curves equal, thus correcting for the large differences in exposure necessary to get a good film at each voltage.

Note that half the 50 kv. spectrum falls on the K absorption peak for iodine, but only a quarter of the 40 kv. spectrum.

Actual measurements of the densities of shadows produced were apparently not made. Newell (2), in attempting to standardize gall-bladder shadows, made no study of the relation of contrast to tube voltage. He took it to be obvious that one ought to use the lowest practical voltage consistent with exposures short enough to avoid movement, accepting 60 kv. as the best compromise.

With the advent of the rotating anode tube, lower voltages have become practical. We, therefore, set about making a set of gall-bladder standards for 50 and 40 kv. To our surprise, the shadows looked the same as at 60 kv. (Fig. 2).

Reference to Figure 1 makes this paradox understandable. At 50 kv. constant potential (60 to 70 kv. pulsating) the peak of the x-ray spectrum comes just on the short wave side of the K absorption edge of iodine. At 30 kv. constant potential (say, 40 kv. pulsating) the peak falls right in the trough of selective transparency on the long wave length side of the absorption edge.

Having been led thus to the practical conclusion that 70 kv. is as good as 40 for tetraiodo. examinations, we wondered if we might not make the higher voltage show an even better shadow by using a filter selectively absorptive for just those wave lengths in which iodine is selectively transparent. We made some preliminary trials with filters of barium sulphate and of cerium sulphate, but shadows did not appear any better.

Then at moderate voltages we tried filters of silver and of molybdenum, hoping to cut off the short end of the spectrum,

yet avoid the low efficiency of extremely low tube voltages. This scheme also yielded nothing worth while.

water). With care, a visible shadow can be obtained of one-eighth per cent NaBr, while one-eighth per cent NaI remains completely

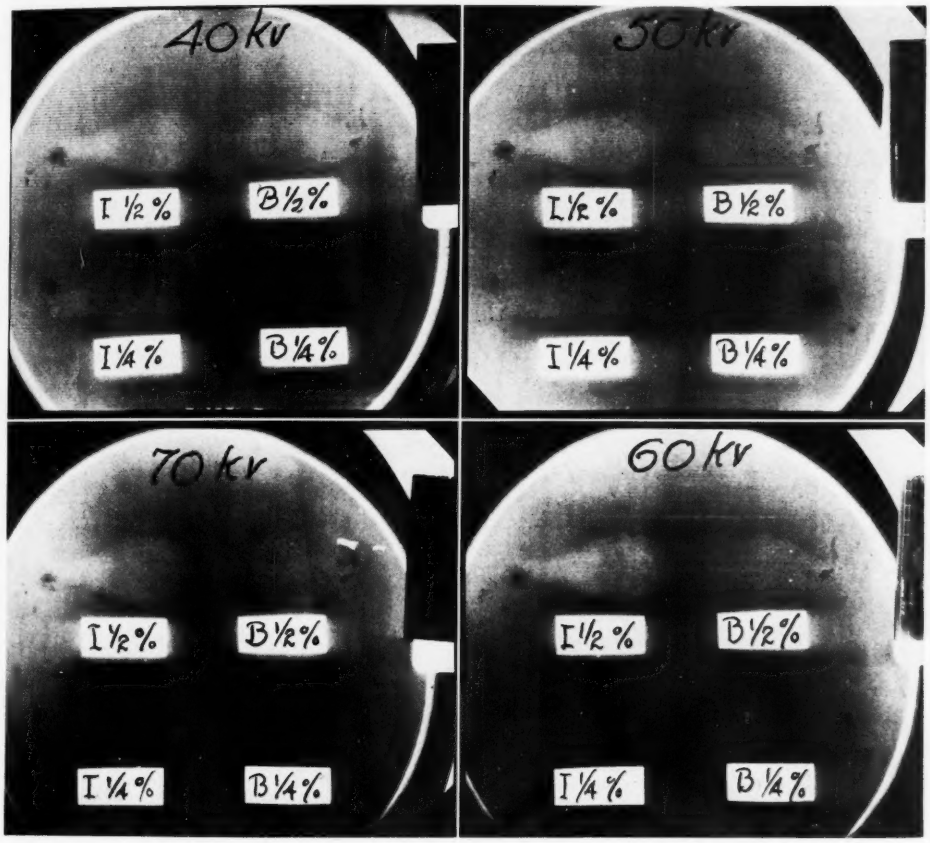

Fig. 2. Artificial gall bladders. Three cm. rubber bags filled with 0.25 and 0.5 per cent tetraiodo- or tetrabrom-phenolphthalein and immersed in 15 cm. of water. Exposures made at 40, 50, 60, and 70 kv. pulsating (4 valve). Tetraiodo. changes its contrast hardly at all. Tetrabrom. becomes progressively less visible as voltage is raised, until at 70 kv. even 0.5 per cent tetrabrom. is hardly seen.

Another possibility was to go back to tetrabromphenolphthalein. There is a long range of wave lengths (from 0.92 Å. to 0.37 Å.) for which bromine is more than twice as opaque as iodine (gram for gram). If we use this range of wave lengths, tetrabromphenolphthalein ought to cast better shadows than tetraiodophenolphthalein. Figure 3 confirms this. We could show tetrabrom. in half the concentration needed for tetraiodo. (but only at lowest practical kv. and smallest depth of immersion in invisible (in a 34 mm. rubber bag in 4 cm. of water). For practical visualization of the gall bladder, tetrabromphenolphthalein will not be better than tetraiodophenolphthalein, unless it proves, on further trial, to accumulate in higher percentage concentration, or to lead to fewer unpleasant reactions.

Tetraiodo. by mouth produces unpleasant symptoms of some degree in 60 per cent of patients (3). A few patients have an idiosyncrasy to iodine. These

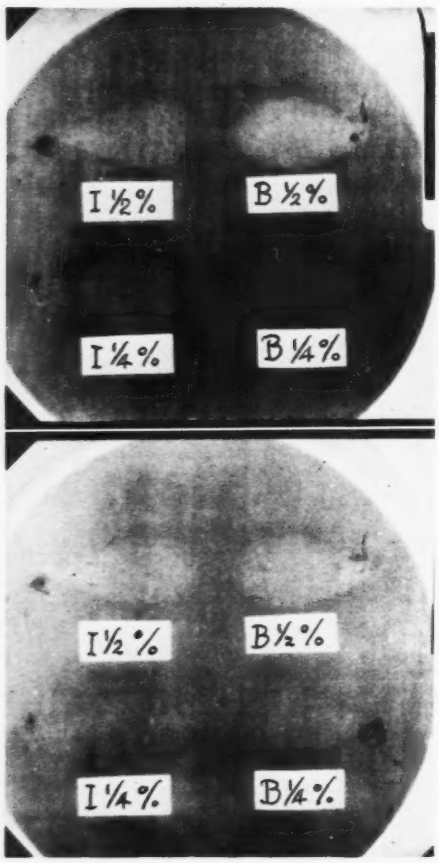

Fig. 3. At 40 kv. (lower film) tetrabrom. and tetraiodo. appear nearly equal. But at 30 kv. (upper film) 0.25 per cent tetrabrom. is almost as dense as 0.5 per cent tetraiodo.

considerations make tetrabrom. appear worth a clinical trial.

If we do continue to use tetraiodo., then as far as gall-bladder visualization is concerned we may as well use 70 kv. and take the shorter exposures thereby available. (The necessity of an efficient Bucky diaphragm is obvious.) For showing calcified stones, however, we shall continue to use the lowest practical kilovoltage.

SUMMARY

We sought to improve the contrast of gall-bladder visualization by: (*a*) Lower tube voltage; (*b*) selective filters, and (*c*) substitution of tetrabromphenolphthalein for tetraiodophenolphthalein.

The tests were done on artificial gall bladders. They gave no useful betterment.

Tetrabromphenolphthalein might be given a further clinical trial if there be hope that reactions might be less or excretion better.

Using tetraiodo., 70 kv. gives as good contrast as 40 kv.

REFERENCES

(1) GRAHAM, E. A., and COLE, W. H.: Roentgenologic Examination of the Gall Bladder: A New Method Utilizing Intravenous Injection of Tetrabromphenolphthalein. Jour. Am. Med. Assn., **82,** 613, 614, Feb. 23, 1924.

(2) NEWELL, R. R.: Roentgenographic Estimation of Concentration of Tetraiodophenolphthalein in the Gall Bladder. Am. Jour. Roentgenol. and Rad. Ther., **17,** 443–446, 1927.

(3) NEWELL, R. R., and LEEF, EDWARD: Cholecystography with Tetraiodophenolphthalein by Mouth: Experience with Regard to Success and Untoward Reactions. RADIOLOGY, **23,** 31–34, July, 1934.

PROTRUSION OF THE APPENDICEAL STUMP FOLLOWING APPENDECTOMY[1]

By MAURICE FELDMAN, M.D., *Baltimore, Maryland*

IRREGULARITIES of contour of the cecum are commonly observed following appendectomy. Deformities of the cecum, exclusive of intrinsic organic pathology, may be due to operative procedures, adhesions, or extrinsic changes. The clinical and roentgenologic significance of deformities of the cecum due to various operative procedures has not been given much consideration. A perusal of the available literature shows but few reports on this subject. Artner, in 1929, found that in one-third of the appendectomy cases peculiar shadows are to be seen in the region of the appendiceal stump, of which 8 per cent revealed a ring formation. He ascribed these deformities of the cecum as being due to the following causes: (1) circular suture with invagination of the stump, resulting in a ring formation; (2) the *Z*, and transverse sutures lead to irregularity of contour and shape.

In this presentation, protrusion of the appendiceal stump following appendectomy will be considered. The purpose of this paper is to call attention to the various types of deformities that may occur in the cecum following appendectomy, as well as to point out their clinical significance and differential interpretation from organic cecal disease.

In a roentgenologic review of about fifty appendectomy patients on whom a barium colon enema had been performed, two cases of protrusion of the appendiceal stump had been observed. A number of other minor deformities, such as slight contour defects, serrations in contour, and evidence of ileocecal adhesions, were also noted. Slight contour or ring defects rarely offer any difficulty in interpretation. However, there may be marked deformities with narrowing of the cecal lumen, which may require a careful study in order to eliminate the possibility of cecal disease.

In protrusion of the appendiceal stump, the deformity is ordinarily seen in the appendix region, on the inner aspect of the cecum. The defect is roentgenologically portrayed by a nipple-like protrusion, with a symmetrical indentation on each side of the nipple defect. This formation may be produced by the following operative procedures: (1) relaxation of the purse-string suture area, the base of the appendix herniating through it; (2) the nipple-like protrusion may represent the base of the appendix, which had not been entirely resected; (3) an abnormal pull on the ceco-appendix area following the "tie and drop" operative procedure.

In the two cases presented, the terminal ileum was adherent to the cecum. There was no tenderness on palpation over the deformed area. The nipple protrusion filled and emptied coincidently with the

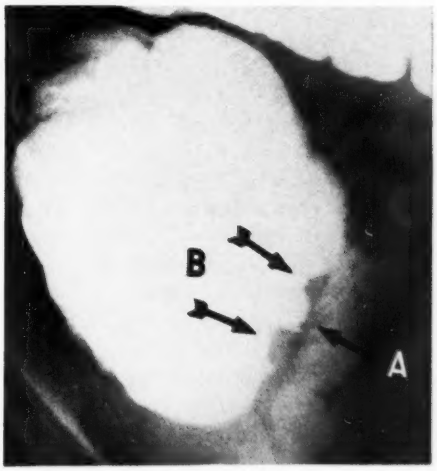

Fig. 1. Post-appendectomy cecum, showing a large nipple-like protrusion at arrow, *A*, and the smooth depression at arrows, *B*.

[1] Accepted for publication in February, 1939.

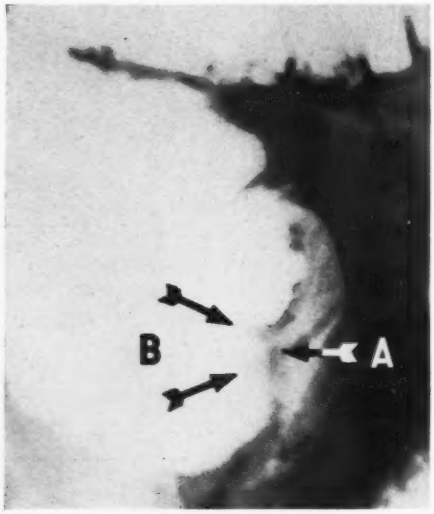

Fig. 2. A small nipple-like protrusion is shown at arrow, *A*, with depression at arrows, *B*, in a post-appendectomy case.

cecum during the barium-enema examination. This deformity has no clinical significance and should not be confounded with deformities due to organic pathology. The condition must be differentiated from ileitis involving the ileocecal valve, inflammatory changes in the cecum, amebic infection, tuberculosis of the cecum, and early carcinoma of the cecum. The differential diagnosis need not be discussed, as the conditions mentioned generally show more or less pathognomonic changes. The regular, smooth, nipple-like protrusion, surrounded by a smooth depression in the appendiceal area, with a history of appendectomy and no clinical symptoms relating to the cecal area, should point to an absence of organic disease.

Illustrative roentgenograms of the two cases are shown, which demonstrate the typical deformity described. This deformity of the cecum is best observed following a barium-enema examination.

2425 Eutaw Place

REFERENCE

(1) ARTNER, H.: Der Status post appendectomiam im Röntgenbilde. Fortschr. a. d. Geb. d. Röntgenstrahlen, **39,** 609–615, April, 1929.

ODONTOMAS[1]

CASE REPORT

By L. A. MALONE, M.D., *Terre Haute, Indiana*

A RELATIVELY large and rare group of primary tumors of the jaw arising from the embryologic structures of the tooth or remnants of the tooth germ have been known for many years, but, as with many other conditions in medicine, they are not fully understood. These are of primary interest to the dental profession but should also be of interest to radiologists if not to the entire medical profession.

The tooth follicle from which a tooth develops is made up of both epithelial and mesoblastic tissue. The enamel organ develops from an epithelial cord originating in the mucous membrane of the mouth, while the papilla, which forms the tooth pulp, cementum, and dentine, comes from the mesoblastic tissue growing into the invaginated enamel organ. These structures are, in turn, surrounded by a fibrous sheath known as the tooth sac.

All of the tumors under discussion arise from one or more elements making up the tooth follicle. There is considerable confusion both as to classification and identification. Some writers contend that the cystic types should not be classed with the solid and calcified tumors. The most widely accepted classification is that submitted by a special committee of the British Dental Association (1), which includes all types. This would also appear to be preferred from the radiologic viewpoint. Every primary tumor of the jaw arising from one or more of the dental formative organs, therefore, becomes an "odontoma," a word derived from two Greek words meaning *tooth* and *tumor*.

I. Epithelial Odontomas.
   (*A*) Multilocular cysts.
   (*B*) Dentigerous cysts.
   (*C*) Dental cysts.

II. Composite Odontomas.
   (*A*) Irregularly calcified tumors.
      1. Complex composite odontomas.
      2. Compound composite odontomas.
   (*B*) Tooth-like tumors.
      1. Geminated composite odontomas.
      2. Gestant composite odontomas.
      3. Enamel nodules.
   (*C*) Dilated composite odontomas.
      1. Dilated crown.
      2. Dilated whole mass.
      3. Dilated root.

III Connective-tissue Odontomas.
   (*A*) Fibrous odontomas.
   (*B*) Cementomas.

I. Epithelial odontomas, as the name indicates, are the result of an abnormal development in the epithelial elements alone.

(*A*) *Multilocular Cysts.*—These have also been known as adamantinomas. They are seen twice as frequently in women as in men, and are but rarely seen in the maxilla as compared to the mandible. They appear most frequently between the ages of 20 and 35 years, being slow in growth and painless. The tumor is made up of separate epithelial-lined cysts of varying sizes and numbers. The septa may be purely fibrous or contain bone. The epithelial lining shows varying degrees of proliferation, sometimes producing an almost solid tumor. There are indications that at least part of these tumors originate from the gingival epithelium and some, at least, either undergo malignant change or are primarily malignant in that they have the appearance of basal-cell carcinomas and have been known to metastasize, especially after incomplete removal.

[1] Accepted for publication in February, 1939.

(*B*) *Dentigerous Cysts.*—This is a cystic condition developing as a result of changes in the dental epithelium about the crown of an unerupted tooth. A glairy viscid fluid collects about the crown and may include the entire tooth. These cysts are twice as frequent in the mandible, involving the canine and third molars most frequently. The average age at which they appear is 15 years and they occur with equal frequency in both sexes.

(*C*) *Dental Cysts.*—These are secondary to infection and are usually associated with pulpless teeth. The cyst usually occurs at the tooth apex but may form at the side of the tooth if an opening from the pulp canal is present. Such cysts are the result of stimulation by infection of the rests of Malassez, which are epithelial remnants of the sheath of Hertwig (2). These may occur at any age but are usually seen late in life.

II. Composite odontomas are tumors containing both epithelial and mesoblastic tissue.

(*A*) *Irregularly Calcified Tumors.*—These are the result of a primary abnormal development in dental epithelium together with resulting changes in the dentine and cementum. The tumors are encapsulated calcified structures containing enamel, dentine, and cementum. They are usually associated with unerupted teeth and usually occur in the molar regions of either mandible or maxilla. They are seen early in life, in either sex, as slow-growing painless swellings.

1. *Complex Composite Odontomas.*—This type is characterized by a conglomerate mass of calcified tooth structure composed of enamel, dentine, and cementum.

2. *Compound Composite Odontomas.*—These are encapsulated tumors containing numerous teeth, portions of teeth, or denticles. They result from many small enamel organs.

(*B*) Tooth-like tumors are divided into three groups, as follows:

1. *Geminated Composite Odontomas.*—These are tumors of two or more teeth with fusion occurring either between the enamel or, more frequently, between the cementum accompanied by an over-production of dentine (4). The teeth may be normally formed or show two crowns and one large irregular root, or the converse. They are usually seen in the mandible.

2. *Gestant Composite Odontomas.*—These are tumors composed of a denticle contained within the walls of a tooth. They are thought to result from a separation of epithelial cells from the sheath of Hertwig during growth of the tooth.

3. *Enamel Nodules.*—These are globular masses of dentine covered by enamel situated most commonly at the juncture of the buccal roots of maxillary molars.

(*C*) *Dilated Composite Odontomas.*—These are tumors having the form of a dilated tooth containing a hollow or depression and a circumference in some parts greater than that of a normal tooth. They result from a small part of the tooth-germ epithelium invaginating the dentine papilla and carrying with it a core of connective tissue. The epithelium usually derives from the enamel organ and enters the dentine through the crown. The tooth-like form probably results, rather than a complex composite type, due to the greater age of the epithelium and a more mature remainder of a tooth (3). The bone about the roots frequently becomes infected even though the tooth is unerupted.

III. *Connective-tissue odontomas* are tumors which are the result of abnormal development in the dental tissues of mesodermic origin.

(*A*) *Fibrous.*—Fibrous tissue proliferates, forming a fibroma made up of concentric layers of white fibrous tissue. There may be calcification of varying degree in the center. Such tumors are often associated with rickets.

(*B*) *Cementoma.*—If the above fibroma becomes entirely calcified, it is then called a cementoma. The tumor appears as a fine granular mass.

The problem of differential diagnosis between the various types of odontomas is usually not difficult; however, conditions other than odontomas are often trouble-

some. A careful history, physical examination, consideration of age, and rate of growth are very helpful. Other lesions requiring consideration in making a differential diagnosis are osteomyelitis, periosteal lesions, giant-cell tumors, fibrosarcoma, carcinoma, myxoma, osteitis fibrosa cystica, multiple myeloma, metastatic carcinoma, osteoma, and areas of condensing osteitis.

Osteomyelitis and periosteal lesions are non-expansile and offer little difficulty in differentiation, although osteomyelitis may be present secondarily with numerous conditions. Giant-cell tumors are most commonly found at the symphysis and ascending ramus and their growth is usually rapid. A central bone-destructive lesion of three or more centimeters may be a dental root cyst, dentigerous cyst, central fibroma or sarcoma, giant-cell tumor, or squamous-cell carcinoma from the mucous membrane of the mouth (5). A solid or monocystic multilocular cyst cannot be differentiated from other central tumors. Cementomas are sometimes impossible to distinguish from osteomas and areas of condensing osteitis.

Treatment of the odontomas is, with one exception, relatively simple. Complete enucleation of the tumor and capsule with closure of the small cavities and packing of the large ones with iodoform gauze usually gives a good result. Atypical root abscesses or cysts are an indication for sectioning of tissue attached to the tooth, to determine whether or not there are malignant changes present (5). After removal of fibromas, cauterization is also indicated because of the possibility of sarcomatous changes.

The "problem child" of this group is the multilocular cyst or adamantinoma. Some believe that these tumors will not metastasize if no attempt at removal is made. However, the local growth becomes quite distressing. Bloodgood (6) recommended complete removal of the single cyst types with chemical cauterization. Most authorities agree that, in the large multilocular type, radical resection should be done without leaving even a bony bridge, since recurrence almost invariably takes place at that point.

Fig. 1. Lateral view of left mandible showing a complex composite odontoma at site of the lower first and second molars.

Case Report.[2]—J. W., white female, aged seven years. Swelling in the left mandible was discovered through pain one week previously. Palpation revealed a tumor mass about midway of mandibular ramus measuring 3 cm. in length and 1.5 cm. in vertical dimension. On the inferior margin of the mandible two small sharp points in close approximation could be palpated.

On x-ray examination, lateral films of the left mandible revealed an irregular collection of calcified material at the site of the lower first and second permanent molars. Only a remnant of the second molar remained, while the first molar was forced downward to the point where its roots ex-

[2] I am indebted to Paul Zwerner, M.D., referring physician, and to H. W. Bopp, M.D., operating surgeon, for the privilege of reporting this case.

tended below the inferior margin of the mandible. The tumor had a delineated marginal outline and appeared to have expanded by pressure erosion. A submental view revealed a spreading of both plates of the mandible resulting in a separation of slightly more than a quarter of an inch with the tumor interposed. X-ray diagnosis: odontoma.

The tumor was removed intra-orally. Removal was piecemeal, with particles varying in size from small granules to that of a large kidney bean.

Pathologic Report.—Gross specimen consisted of a nodular mass, measuring 2 × 2 × 0.6 cm., of stony consistency and many small calcified bone-like nodules. Microscopic sections from decalcified material showed the tumor to consist of spicules of bone and cells rich in connective tissue, including groups of elongated columnar cells, some of which resembled enameloblasts. There was no evidence of malignancy. Diagnosis: odontoma.

A calcified conglomerate mass in the mandible which contained enameloblasts placed it in the complex composite odontoma group.

Summary.—A review of a group of primary tooth tumors is presented, together with the most generally accepted classification. In addition, a case of complex composite odontoma is reported.

415–417 Tribune Bldg.

BIBLIOGRAPHY

(1) GABELL, JAMES, and PAYNE: Special Committee Report on Odontomes. British Dent. Assn., 1914.

(2) SPRAWSON, EVELYN: Odontomes. British Dent. Jour., **62,** 177–202, February, 1937.

(3) RUSHTON, MARTIN A.: A Collection of Dilated Composite Odontomes. British Dent. Jour., **63,** 65–86, July, 1937.

(4) GULLIFER, HARRY: Odontoma. Am. Jour. Orthodontics and Oral Surg., **24,** 795–800, August, 1938.

(5) KEGEL, R. F. C.: Central Tumors of the Lower Jaw. RADIOLOGY, **16,** 216–223, February, 1931.

(6) BLOODGOOD, JOSEPH C.: Method of Operative Attack for Central Lesions of Lower Jaw. New York St. Jour. Med., **24,** 379, March 21, 1924.

MULTIPLE DIVERTICULA OF THE JEJUNUM, DUODENUM, AND COLON, WITH REPORT OF A CASE[1]

By STAKELY HATCHETTE, M.D., *Lake Charles, Louisiana*

WHILE multiple diverticula of the colon are so common as to be frequently noted on gastro-intestinal examinations, and duodenal diverticula are occasionally seen, diverticula of the jejunum would seem to be a rare condition, if one may judge from the number of cases of this condition reported in the literature. Helvestine (8), in 1923, was able to find only 27 cases of these diverticula which had been reported. Gisbertz (5) was able to find only a total of 50 cases of diverticula of the jejunum or ileum for his compilation of the literature in 1930. Stiven (12), in 1934, stated that diverticula of the jejunum and ileum were very rare and expressed the opinion that there were only about 60 such cases on record. Schmidt and Guttman (11) reported a single case of multiple diverticula of the jejunum and duodenum in 1934. Case (3), in 1920, in an analysis of 6,847 gastro-intestinal examinations, was able to find only five cases of jejunal or ileal diverticula. In this same series, he reported 85 cases of duodenal diverticula, an indication that these are fairly frequent in occurrence. Köhler (9) called attention to the presence of fluid levels in jejuno-ileal diverticula when the patient was fluoroscoped or roentgenographed in the erect position. In discussing the differential diagnosis, Köhler mentioned the possibility of confusing these diverticula with multiple small intestinal obstructions associated with tuberculous peritonitis, diverticula of the stomach, duodenal, or duodeno-jejunal diverticula, and Meckel's diverticulum. In the case herein reported, no difficulty was experienced in determining the location of either the duodenal or jejunal diverticula, it being a very simple matter to observe the progress of the barium meal down the intestinal tract by means of the fluoroscope, to watch the filling of the diverticula, and to determine the relationship of these barium filled diverticula to the stomach and other portions of the intestinal tract. Schmidt and Guttman suggested that a duodenal tube may be used to fill the intestines separately should there be any difficulty encountered in differentiating these diverticula from other conditions with which they might be confused. This method was suggested by Buckstein (2) as a means of demonstrating duodeno-jejunal diverticula.

Barclay (1) states that diverticula of the jejunum "are not common, and may be single or multiple." Harrison (7) has little to say of diverticula of the small bowel other than that they attain their largest size near the duodeno-jejunal flexure, that they may be due to traction deformities or the result of congenital weakness of the intestinal wall, and that they rarely occur before the age of forty. He makes no specific mention of jejunal diverticula. Golden (6) states that, "diverticula of the small intestine below the duodenum are not very common." Feldman (4), who collected a large number of references for his discussion of diverticula of the jejunum and ileum, says, "diverticula of the jejunum are rarely observed roentgenologically. They occur less frequently in the jejunum than in any other portion of the gastro-intestinal tract." In discussing diverticula of the duodenum, Melville (10) states that acquired diverticula are generally found in the first part of the duodenum as a result of ulceration, that these are "true diverticula" and "they are not supposed to produce symptoms." Melville also states that congenital diverticula are generally found in the second part of the duodenum, rarely in the third

[1] Accepted for publication in April, 1939.

part, and never in the first part. These congenital diverticula are described as being deficient in muscular layers, and, for that reason, are called "false diverticula." Golden says that jejunal and ileal diverticula are of the "false" type similar to "false" duodenal diverticula. Feldman states that these diverticula begin as small pouches containing all the coats of the intestine which herniate through the weakened wall, that they are thin walled and, like diverticula elsewhere in the intestinal tract, are a protrusion of the mucosa through the muscular coat. While most diverticula of the jejunum are found accidentally at autopsy and are usually symptomless during life, cases have been reported in which they produced definite clinical symptoms. Terry and Mugler (13) have reported a case in which an enterolith formed in a jejunal diverticulum, which caused an intestinal obstruction requiring surgical operation. At the time of examination, this patient was free of all complaints except "indigestion," so it cannot be estimated to what extent the diverticulosis might have been responsible for her symptoms. There did seem to be a certain degree of dilatation of the jejunum which might indicate the possibility of an organic or functional derangement in this area, and which, it would seem, might account, to some degree, for the symptoms complained of (Figs. 1 and 2).

Case Report.—Miss M. H., white female, aged 53 years, a schoolteacher, was referred to the writer by Dr. R. P. Howell, of Lake Charles, La., on Jan. 14, 1939, for a gastro-intestinal examination. She gave a history of having recovered within the past few days from a "stomach upset" which was accompanied by nausea, colicky pain in the epigastrium, "indigestion," and occasional attacks of vomiting. She stated that she had suffered from nausea, "indigestion," and vague gastro-intestinal distress for some years, and that her symptoms had come on so gradually she could hardly estimate just when they began. During these years, her symptoms had

Fig. 1.

Fig. 2.

Fig. 1. Roentgenograph made immediately after initial fluoroscopic examination. Both duodenal and jejunal diverticula are shown.

Fig. 2. Made after two hours. The duodenal and jejunal diverticula are much better shown. The jejunum shows some degree of dilatation.

gradually become more and more severe until she was forced to seek medical advice. The family history was negative. In her past medical history it was stated and confirmed that she had had intensive irradiation over the left half of the chest six years previously for a Grade IV adenocarcinoma of the left breast. A biopsy had been taken after the administration of 900 r units to the tumor and the diagnosis of the adenocarcinoma had been made by a competent pathologist. Upon completion of irradiation, a radical mastectomy was performed. Study of the whole breast and axillary lymph glands failed to show any cancer cells remaining, though attention was called to an extensive infiltration of the breast tissue by connective tissue cells.

At the time of the gastro-intestinal examination, the patient appeared to be in good physical condition, having recovered from one of her irregular attacks of vomiting a few days before. Her temperature was 98.4 F.; pulse 82. The Wassermann and Kahn reactions and the urinalysis were negative. Blood examination: Erythrocytes, 5,200,000; leukocytes, 10,625 (polymorphonuclear leukocytes, 88 per cent, small lymphocytes, 10.33 per cent, monocytes, 1.67 per cent); hemoglobin, 87 per cent; color index, 0.83; polychromasia present (1 plus); toxic granules in cytoplasm of polymorphonuclear cells. Gastric analysis: free HCl, 0; combined acidity, 4; no occult blood; mucus, 3 plus.

Roentgenologic examination: No abnormalities of the esophagus or stomach were noted either fluoroscopically or roentgenographically. During the fluoroscopic examination a number of fairly large diverticula were noted in both the duodenum and the jejunum. It was a most interesting experience to watch the barium fill these pockets during the observation of the passage of the meal through the upper portion of the small intestine. Palpation of these diverticula caused some of them to empty, only to have them refill by the next measure of barium that entered the duodenum. Deep palpation over the jejunum caused the patient to complain of tenderness and nausea to a slight-to-moderate extent. Additional short fluoroscopic examinations made two and six hours later, respectively, showed the diverticula even more plainly than the first one. Roentgenographic examination demonstrated the diverticula well (Figs. 1 and 2). There was a moderate retention of barium in the stomach at the end of six hours. The 24-hour roentgenogram showed multiple diverticula of the colon, a spastic colon, a few shreds of barium-impregnated mucus in the lumen of the colon, and barium retention which was felt to be in the jejunal diverticula (Fig. 3). The chest was negative for carcinomatous manifestations.

Fig. 3. Twenty-four-hour observation. Multiple diverticula of the colon are present. A small amount of barium still remained in the duodenal and jejunal diverticula and may be seen above the colon.

REFERENCES

(1) Barclay, A. E.: The Digestive Tract: A Radiologic Study of its Anatomy, Physiology, and Pathology, p. 271. University Press, Cambridge, 1933.

(2) Buckstein, J.: The Duodenogram Applied to the Demonstration of a Duodenojejunal Diverticulum. Am. Jour. Surg., **3,** 340, 341, 1927.

(3) Case, J. T.: Diverticula of the Small Intestine, Other than Meckel's Diverticulum. Jour. Am. Med. Assn., **75,** 1463, 1920.

(4) FELDMAN, M.: Clinical Roentgenology of the Digestive Tract, pp. 525–530. William Wood & Co., Baltimore, 1938.

(5) GISBERTZ, H.: Quoted by Schmidt, E. A., and Guttman, P. H. (11).

(6) GOLDEN, ROSS: Diagnostic Roentgenology, p. 310. Thomas Nelson & Sons, New York, 1938.

(7) HARRISON, B. J. M.: A Textbook of Roentgenology: The Roentgen Ray in Diagnosis and Treatment, p. 333. William Wood & Co., Baltimore, 1936.

(8) HELVESTINE, F., JR.: False Diverticula of the Jejunum. Surg., Gynec. and Obst., **37,** 1–5, July, 1923.

(9) KÖHLER, A.: Roentgenology, p. 504. William Wood & Co., New York, 1931.

(10) MELVILLE, A. G. G.: A Case of Absence of the Gall Bladder and Duodenal Diverticulosis. Acta Radiol., **18,** 65–70, 1937.

(11) SCHMIDT, E. A., and GUTTMAN, P. H.: Multiple Diverticula of the Jejunum and Duodenum Simulating Gastric Diverticula and Complicated by Cholelithiasis. Am. Jour. Roentgenol and Rad. Ther., **31,** 200–203, February, 1934.,

(12) STIVEN, H. E. S.: Quoted by Feldman (4).

(13) TERRY, W. I., and MUGLER, F. R.: Diverticula of the Jejunum. Arch. Surg., **2,** 347, 1921.

RECENT ADVANCES IN NUCLEAR PHYSICS[1]

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I WOULD like to relate some of the results that have been obtained by physicists in the general field of nuclear physics within the past five or six years. For the benefit of those who have not had time to follow these developments and who may be somewhat curious about them, I shall discuss the subject in quite an elementary way, in spite of the fact that I shall necessarily thereby repeat things which are quite well known to many persons who have been particularly interested in such developments.

The subject of nuclear physics is one which deals with man's attempts to learn about the innermost parts of the atom. If I may review a little of the history of the development of our knowledge of atomic structure, I will say that modern views date from about 1912, when the Bohr theory was developed. At that time it became abundantly evident that all matter consists of atoms which are built on a particular plan, often described as analogous with the solar system. That is, the central part of the atom is a nucleus where most of the mass of the atom resides, and surrounding that are electrons which are bound there and which are responsible for the chemical properties.

This view, put forth by Bohr, in 1912, has been the subject of most of the attention of physicists and theoretical chemists since that date until the present, but especially there was a rather "closing-up" development about 1928 or 1930, and physicists now feel that all the chemical properties of all the elements can be explained in terms of this picture because of the numerous successes which it has had.

All of the facts of spectroscopy, both atomic and molecular, and a great many of the facts of chemical binding, in simpler cases in which mathematical difficulties are not too great, have been very successfully related to this theory of the structure of the atom and that part of the development only involves a consideration of the outer structure; that is, of these electrons which are outside of the nucleus.

It was not until about 1928 that attention began to be devoted to the problem of the structure of the nucleus, itself.

I think by following the analogy with the solar system it can be understood why there might be two rather different scientific problems presented there. In the solar system, one has the problem of explaining the motion of the planets, the motions of the various planets around the sun and around their parent bodies, and in that problem one really does not need to consider what the sun is made of or why it is hot as it is, or anything at all about its internal structure. It functions, for that purpose, only as a huge central mass which is able to attract the other planets.

So, likewise, in the atom. The nucleus is a large central mass which, for purposes of studying the main facts of spectroscopy and of chemistry, needs only to be considered as a thing which exerts electric forces on the electrons and keeps them moving around the central nucleus.

As time went on it became more and more interesting to devote attention to the nucleus. One might wonder, Why not start right away or why start at that time? I would say the reason physicists became interested in the nucleus about ten years ago was a double one. In the first place, there were developments of theoretical ideas which brought the problem more to the forefront. At the same time, there were developments of experimental technic which made it more possible to study the problem than had been the case hitherto.

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The theoretical developments were accompanied by the general development of what we know as quantum mechanics—the newer mathematical theory of the structure of the atom in which all particles are recognized as having a dual nature by which they exhibit both particle-like properties and wave-like properties.

This theoretical development provided, for the first time, a clear understanding of the nature of what is going on in a radio-active decay process such as that in which an alpha particle is emitted by radium.

The most important contribution of the theory was an understanding of this curious relation, known as the Geiger-Nuttall relation, between the energy with which the alpha particles are sent out by various radio-active bodies and the mean decay life of the radio-active bodies. This relation, remember, is an extraordinary one in that we have a logarithmic relation between the mean decay time of the various known natural radio-active elements and the energy of the alpha particles which they send out.

Confining attention to those elements which do emit alpha particles, uranium, for example, sends out a rather low energy alpha particle and has a mean life of about a billion years. On the other hand, the extremely short-lived decay products in the radium series are those which send out exceedingly high energy alpha particles.

The explanation of this curious relation depends on an essential departure of the behavior of the particles of Nature on an atomic scale from the laws of mechanics as they were known from Newton's time up to the present.

Mainly, it was found that owing to this wave-like nature of the particles they were able to go through regions where they could not go according to the classical ideas. Classically, if you are on one side of a hill and you want to get over to the other side and you have not energy enough to go over the top, you just cannot get through. However, if I consider a wave analogue of that, the wave analogue permits me to get through.

If I have light coming up from glass and attempting to get out, and send the light up to such an angle that it is beyond the critical angle so that it is totally reflected internally, it is common to say that the light does not get through, but now if I bring another piece of glass down to that first piece—not touching it but with just a very small distance between them—then the light is able to get through in spite of the fact that it is totally reflected internally, that is, a small amount of it is able to get through.

So, likewise, it is possible in this newer form of wave mechanics for particles to get through places where they otherwise could not get through according to the old views, and that afforded the key to the radio-active decay processes.

That same idea greatly stimulated nuclear research because previously it had been estimated that one would need at least five to ten million volts energy for particles to bombard the nucleus and get in close enough to it; in spite of the fact that the positive charge on the particles makes them repelled by the positive charge on the nucleus, it was thought that one would need some five or ten million volts to get in close enough to make an impact sufficient to get into the inside of the nucleus and do something to it. It was thought that these extremely high voltages would be needed to get any effect at all.

At that time no means were known for getting such high voltages and so experimental work was somewhat delayed. However, this wave mechanical view of the nature of radio-activity made it clear that particles might penetrate into the nucleus even if they did not, properly speaking, by the older views, have energy enough to get in. That is the way in which this work was greatly stimulated by the new views.

Since 1928, then, there has been a great deal of activity in this field. The main discoveries, if I may hurriedly recite

them, are, first, the discovery of the existence of a new kind of particle which had not been recognized before 1932, and which is known as the neutron. The neutron is apparently a particle just like the nucleus of the hydrogen atom in that it has essentially the same weight as the hydrogen atomic weight, but it is neutral instead of having a positive unit charge such as the proton has.

This discovery, in 1932, made possible a number of important theoretical developments. It completely revised the picture of the composition of the atomic nucleus. One may try to think of what a nucleus is made; for example—just to consider a light one in which the arithmetic will be simple—the helium nucleus. It has two units of charge, as we know from the fact of direct measurements, and it also has a mass of four on the atomic weight scale. If the only particles you ever heard of were protons and electrons, which was the case until 1932, it is a simple matter of bookkeeping. Electrons have a rather negligible mass; it takes four protons to get the necessary mass, but if that is done there will be four units of charge so a couple of electrons are tossed in to neutralize two units of the charge and a structure is left which consists of four protons and two electrons. That balances the mass and the charge.

There are a great many difficulties about this view, of a theoretical nature. Difficulties of a theoretical nature are never to be taken too seriously because one can always change the theory, but, nevertheless, if the theory is very, very good in many other respects, one shows a great reluctance to discard it if to do so can possibly be avoided.

There were grave difficulties in the attempts to put electrons into a space as small as the size known to be occupied by the atomic nucleus. Consequently the neutron discovery was of great help to theoreticians on that account, because with that it was possible also to get another view of the composition of the nucleus, namely, to postulate that it is made of protons and neutrons. It is just as easy to balance the books that way.

Take enough protons to get the charge of a given nucleus; then, since the mass always exceeds the charge, take enough more neutrons to get the extra mass and they do not give any more charge, so the result is satisfactory.

That is a much more reasonable view of the composition of the nucleus and is the one held generally by physicists to-day and in terms of which all modern discussions are held.

The main fundamental problem of the nuclear physicist, of course, is to try to determine the nature of the forces which hold these particles together and thus makes matter exist at all.

If we suppose, now, that the basic constituents out of which all matter of all chemical kinds is made are the three kinds, namely, the proton, the electron, and the neutron, we have, in the case of the proton-electron, the well recognized electrical forces of attraction between them and that is what holds the electrons to the nucleus in a neutral atom, but the protons, among themselves having like charges, repel each other electrically and also the neutron, being uncharged, has no force—or at least no strong force of an electrical character.

So the question arises: If we take a thing like helium which is made of two protons and two neutrons, why does it stick together? Two protons are repelling each other strongly and the neutrons are apparently indifferent, so the thing ought to fall apart, and, in the absence of new specifically nuclear forces, all matter would evaporate into hydrogen gas plus a lot of free neutrons floating around, which, as you know, it has not done yet!

The central problem we are trying to study, from a theoretical point of view, is, "What is the nature of these forces, these extra forces of a new kind which are effective in the nucleus but not elsewhere?"

That is done by a variety of kinds of experiments but principally one of the most effective kinds is that in which one studies

the angular distribution of scattering of particles. If I were interested in the way in which the force between two particles depends on the distance between them, one way would be to shoot a beam of particles of one kind at a target containing the other and see in what way the particles were distributed in angle after being scattered, because that would be dependent on the force between them. By studying that angular distribution, I could infer things about the force.

That kind of program has been carried out quite extensively in the past few years but not nearly extensively enough to provide a complete solution of the problem by any means. It is known that there are between these particles at extremely small distances (10^{-12} cm.) forces of a new type which are vastly stronger than the electrical forces at that same distance between, say, two protons—something like ten thousand times as strong. It is difficult to give an exact figure because both are functions of the distance in quite different ways, but, roughly speaking, that is the order of magnitude.

From a fundamental point of view, our main object is to learn about these new kinds of forces which have been revealed with a view to finding out how nuclei are put together and why matter exists at all, and then, of course, do something about changing it. That, perhaps, is enough for the general kind of thing about the fundamental problem.

In connection with this work, as you have heard, much nuclear transmutation has been carried out. That means chemical reactions, if you like, in which the equations do not balance in the way you were taught in college to balance them. One was always taught that there must be the same number of atoms of each kind on both sides of the equation. However, in these nuclear processes, all that is required is the same total charge on both sides of the equation and the same total mass, otherwise an atom of one kind can be changed into another. To give a simple example, if I bombard a lithium target with protons, I get helium. That is quite different from the usual chemical reaction and yet I can use the same kind of a notation for it as one uses in chemistry but with this difference: there are not the same kind of atoms occurring on the two sides of the equation.

The simplest case is lithium, with an atomic weight of 7, number of 3, bombarded by protons accelerated to high energies, which reacts to give two helium particles:

$$H^1_1 + Li^7_3 \longrightarrow He^4_2 + He^4_2.$$

As is seen, that balances, so far as both the total mass and total charge are concerned.

That is a reaction known to give off energy in the sense that the motion of these two helium particles—the energy with which they rush apart after they are formed—is vastly greater than the energy put in to the reaction; that is, the energy used to accelerate the proton to make it hit the lithium target.

Probably, so far as we now see, for all time to come that will not be a useful source of energy, simply because the efficiency is so low. It happens that it works out so that of all the protons which go down the tube, only about one in a million makes an effective hit; the others just rush in the target and have their energy dissipated as heat.

It is true that when the reaction does occur there will be about a thousand times as much energy given out as came in, but, even so, a thousand times one millionth gives us an efficiency of a tenth of 1 per cent; so while we are releasing atomic energy we are not doing it in a way practical as a source of energy. Likewise, by the same general consideration, the total amount of helium produced is so small that there is no point in trying to produce helium that way for any use.

The most interesting thing about all new processes is not how to produce well known materials in new ways when there exists a tricky and indirect method like this, but to try to produce materials of a new type. That brings me to the subject

of the artificially radio-active elements which are produced in this way.

When I bombard a target with a particle, I do not always get off familiar, well known elements; sometimes I get off elements of a new kind which are themselves elements which do not occur in Nature. Perhaps that is not the correct usage of the word; I get off elements that occur in Nature, but I get off new isotopic forms of them. That is to say, as you know, the elements which do occur in Nature occur with different masses. The thing that determines the chemical nature of an element is its charge on its nucleus and the number of electrons around it but not the mass.

For example, the common form of carbon would be to put a C and a 6 below (C_6) to remind us that it had 6 electrons in the atom and a charge of 6 on its nucleus, and a mass of 12 (C_6^{12}). There occurs in Nature a less abundant form that has the same charge (that is what makes it carbon), but it has an extra neutron in its nucleus so it is carbon 13 (C^{13}).

One might speculate on why there is not a carbon 14; why does not carbon of mass 11 or 14 occur in Nature?

The answer is that we can, by certain nuclear reactions, produce these materials and when we do produce them we find that they are radio-active and decay and are all gone in a relatively short time; so that, had there been any of this formed in whatever kind of an event the creation consisted of, it would have disappeared a few days after the creation and so none of it would have been left.

If I bombard a target containing nitrogen with neutrons, which I have to obtain from some other bombardment process, then I find that the neutrons will be captured by the nitrogen. The neutron (n^1_0) symbolizes that it has a mass and no charge

$$n^1_0 + N^{14}_7 \longrightarrow C^{14}_6 + H^1_1.$$

I will get C^{14}_6 and what will come off will be a hydrogen atom; but what I find is that, if I stop the bombardment and use ionization methods to study this, I discover that this carbon does not just sit there and remain permanent but spontaneously decays in a radio-active disintegration and reverts to nitrogen in a way so that it emits electrons which are symbolized by mass zero and charge minus one.

$$C^{14}_6 \longrightarrow N^{14}_7 + e^0_{-1}.$$

This happens in such a way that the mean decay life is about three months; it is half gone every three months.

Likewise, by some other reaction I can produce this other kind of carbon; some of this can be produced in a variety of ways and I am citing only a typical instance. If I take a target of boron and bombard it with high speed deuterons, nuclei of the kind of heavy hydrogen discovered by Urey, in 1932, charge 1, mass 2, I get off another new kind of carbon:

$$B^{10}_5 + H^2_1 \longrightarrow C^{11}_6 + n^1_0,$$

and what comes off is determined by the balance; it is one and zero. That is what happens when I bombard boron with deuterons.

But now the C^{11}_6 which is produced is itself not stable but after I cease bombarding it, goes on and is radio-active and goes back to B^{11}_5 by the device of emitting still another kind of particle, discovered in 1932, the positron.

$$C^{11}_6 \longrightarrow B^{11}_5 + p^0_1.$$

The positron is the analogue of the electron, a thing of very small mass, about 0.0005 on the weight scale, so I crudely call it "0," but having a positive instead of a negative electric charge. It happens this decays much more rapidly, so that its half life is only about twenty minutes.

In just the last few years it has been found possible to make all of the elements radio-active, save some of the rare earths, and that is because they have not been studied. One interesting case, from a strictly chemical point of view, is that of masurium. The element, masurium, with an atomic number of 43, as some of you

may know, is so rare that none of it exists, or practically none of it exists, and the chemistry of it has never been worked out. It has been inferred from its place in the periodic table, but that is about all.

Masurium has been prepared in an artificially radio-active form and its chemistry studied in that way. These artificial radio-active elements are undoubtedly going to be of use in two ways for biological science: First, if we can find efficient methods of producing them in large yields, they may be available as substitutes for radium. (By that I mean, not strictly substitutes but things with properties analogous to radium but with other interesting specific properties of their own, for the therapeutic use of their radiations.)

Also, what perhaps may be of more use although it will be more indirect for the science of biochemistry and not so directly used in therapy, is the study of biochemical processes by the use of these artificial radio-active atoms as tracers. Much of that work has already been started. One can easily follow the course of a given amount of material in the body through various processes of metabolism by tracing the course of the radio-active material.

DISCUSSION

KENNETH CORRIGAN, Ph.D. (Detroit, Mich.): We cannot help but notice the interesting analogy which exists in the development of these considerations of nuclear physics, as we are considering them to-day, particularly with respect to artificial radio-activity; and the development of the roentgen ray itself.

The roentgen ray, of course, was discovered as a weak, practically useless, new form of light. The neutron, upon which our work in artificial radio-activity depends, was discovered in much the same form and at first was thought to be a type of gamma ray of an extremely high voltage, and only after a certain amount of experimentation was it found that such was not the case.

From that point on, in both the case of the x-ray and these present developments we are considering to-day, the development has been extremely rapid.

Dr. Condon has pointed out that all of this work he has discussed has been done in the last five or six years. To give you an idea of how much has been carried on, it may be worth while to point out that every element of the periodic table, except hydrogen, has been activated and three extra ones have been done.

This work started slowly and then developed very, very rapidly. We are now at the point where further developments depend upon the things Dr. Condon has pointed out to-day. Basic physics is pretty well along and the thing required now is a great deal of fine engineering so that these developments can be employed for what we choose to call the practical use of artificial radio-active material and perhaps for the far more practical theoretical uses that we cannot as yet fully foresee.

DR. CONDON (*closing*): I have not been able to do anything more than give the merest kind of a bird's-eye view of the subject. For those who are interested in reading more on the subject, I might mention that there have appeared in the last year or two in the literature of physics several books which can be rather strongly recommended. One is by Rasetti, called "Nuclear Physics." Rasetti is a colleague of Fermi, who just received the 1938 Nobel Prize for work in this field. The other is by Feather, one of the younger men at the Cavendish Laboratory, in Cambridge. Both are slightly mathematical in parts but I think there is enough information therein fully reviewing the general field to make them interesting, in part, at least.

I feel that it is highly dangerous to try to predict what the use of these things will be, as it would have been unwise to attempt to predict the future of x-rays in, let us say, 1902. You see the analogy, I am sure, especially as brought out by Dr. Corrigan in his remarks. These

things are all too new for us really to know just what good they are going to be in the sense of application to other fields, so that when one speaks of the use of artificial radio-active materials, as tracers in biochemistry, I think you will see that there are great possibilities.

On the other hand, you must, of course, realize that we have never yet in this world found any new scientific tool that was a panacea and answered all our questions. For example, some of the elements that you might want in radio-active form, in order to do chemical experiments may unfortunately have such extremely short mean lives that their activity is all gone before you can do anything about it; or, they may be just the very ones we find extremely difficult to produce in quantity because some of these reactions go much more readily than others and some have large yields while others have low yields.

On the other hand, we do not know yet what the yields are nor what are the most advantageous ways of producing these things in all cases, as can well be imagined from the newness of the subject.

Therefore, I think it is a field into which everybody should enter enthusiastically, exploring the possibilities of these tools for his own subject, but realizing, as I said, that not every question will readily be answered by this means.

As to the use in biochemistry of tracers, I am not qualified to speak. Some work has been done thus far with radio-active phosphorus in studying phosphorus metabolism. In Rochester, in collaboration with the Physics Department there, some points are being studied (I have to speak vaguely because I do not know about them from a biologic point of view) in the metabolism of iron in connection with anemia—studied by means of using radio-active iron and tracing it in the body.

Radio-active sodium is a favorable thing because it has a mean life of about fifteen hours and is readily produced in relatively good quantities.

Perhaps this will give you an idea about the work which has already been started along this line in the field of biologic applications.

It is also of some importance to know that this same kind of thing is throwing light on metallurgic studies. That is to say, in problems of diffusion of one metal into another, it is quite difficult, by chemical analysis, to study the formation of alloys by the detailed process that goes on in the heat treatment of all alloys in the way of diffusion from one phase to another of the metal by ordinary chemical means, but by following the motion of the radio-active atoms, it looks as though a great deal can be done in this field.

In any case, there is a problem in which the process does not take forever to happen (because, if it did, the radio-activity would all be gone) and in which it is desirable to find what happens to a particular batch of the element that has been introduced into the situation now, in spite of the fact that there is already present a large number of other similar atoms. In this way this radio-active tracer method will be useful.

Of course, the other use of the ordinary, stable isotopes, which also bids fair to be very important there, is a line of development which Professor Urey has been emphasizing in his researches. For example, if you want to study problems in the metabolism of nitrogen compounds, you can take nitrogen which he has prepared and in which there has been an artificially produced large enrichment of the nitrogen 15 (N^{15}) content. Nitrogen, as we know, has ordinarily an atomic weight of 14 but there is about one part in 500 of nitrogen that has an atomic weight of 15.

By fractionation processes which are extremely difficult, he does succeed in getting some nitrogen which is highly enriched in this nitrogen 15. If you synthesize compounds with that, then use them in your biologic experiments, then later take it out—if you have appropriate analytical means for determining nitrogen 15 in the other, not by radio-active means, because this is a stable isotope—you have

there a method of tracing what happened to that particular nitrogen which you introduced.

That method has the advantage that there is no time limitation. That nitrogen is labelled and perfectly stable and will last as long as you want it to. It has the disadvantage, of course, of being rather difficult to prepare, but then, so is it difficult to prepare quantities of the radio-active forms.

It also requires much more difficult and elaborate means of detecting it, since it must be remembered that in all this work we are postulating that the chemistry of nitrogen 15 is so identical with that of nitrogen 14 that the result of these experiments is really going to produce something about the chemistry of ordinary nitrogen. We are really all using a different kind but the conviction exists that the construction is so identical for the two that what we learn with these devices will be useful.

Returning to the radio-active case, it should be mentioned that the electrical methods of detection of these small quantities of artificially radio-active materials are so sensitive that there is no question of using enough radio-active material in a biologic experiment so that the radiations from the material itself will affect the course of the biologic activity. That, of course, is the thing which will have to be subjected to controls in the experiments, and so you can see that this is not a field that is going to be worked out overnight.

There are many similar points to be taken into consideration and I think they will be considered and extensively developed within the next few years when physicists are able to produce reasonable quantities of these new materials.

LOWER LOBE TUBERCULOSIS[1]

By MARTIN J. SOKOLOFF, M.D., *Philadelphia*

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DEVELOPMENT of modern diagnostic procedures has greatly increased our knowledge of chronic pulmonary diseases. New and improved laboratory methods, bronchoscopy, biopsy technics, and serial roentgenographic observations have served not only as an aid to the earlier recognition of these conditions, but also to facilitate the identification of atypical disease manifestations. As a result of the additional knowledge gained through these sources, it has become necessary to revise certain fundamental concepts of chronic pulmonary diseases which, heretofore, have been regarded as almost axiomatic. This has been particularly true in regard to our understanding of the nature and localization of the initial lesion in progressive pulmonary tuberculosis of the reinfection or adult type. Formerly, it was believed that the first lesion in active tuberculosis almost always began in or near the apex of the lung. We now know, however—mainly because of the observations of Assmann (1)—that this lesion frequently occurs in the lung below the level of the clavicle, and that the apex may be involved by extension from this lower focus. Most of these so-called "infraclavicular infiltrations" begin in the upper lobes, although they are also found in the middle or lower lobes (Fishberg, 2).

Prior to the publication of Assmann's observations in 1925, tuberculosis limited to the lower lobe of the lung was considered extremely rare. The earlier literature contains few references to such lesions and many of the older textbooks do not even mention them. Recently, however, considerable evidence has accumulated to indicate that lesions of this type are not uncommon.

Because of the great variation in the frequency of lower lobe tuberculosis, as revealed by different surveys, its actual incidence is difficult to determine. For instance, Dufault (3) found one case (0.27 per cent) among 365 patients with pulmonary tuberculosis and Reisner (4) found 31 (0.68 per cent) in 4,494 patients. On the other hand, Ross (5) discovered 11 (18.3 per cent) among 60 tuberculous nurses. Most investigators, however, report an incidence between these extremes. Thus, Hamilton and Fredd (6) discovered lower lobe lesions in 2.9 per cent of 349 patients, while Weidman and Campbell (7) reported an identical incidence in 1,401 patients. Vizwanathan (8) found primary lower lobe involvement in 5.6 per cent of the males and 10 per cent of the females in a group of 638 tuberculous patients.

This investigation has been conducted primarily for the purpose of comparing the clinical and roentgenographic features of chronic tuberculous lesions, beginning in the lower lobes of the lungs, with those of the more common upper lobe variety. The records of all the patients admitted to the White Haven Sanatorium during the five-year period ending Sept. 1, 1938, have been reviewed. During this time, 1,620 tuberculous patients were treated. This group included 215 anthracite coal miners who had combined anthracosilicosis and tuberculosis. Because of the difficulty of localizing tuberculous lesions in the presence of extensive anthracosilicosis, these men were not included in the study. Among the remaining 1,405 patients there were 24 (1.7 per cent) in whom the tuberculous processes began in the lower lobes of the lungs. These atypically located lesions were found in six (0.7 per cent) of 905 males and in 18 (2.5 per cent) of 715 females who comprised the group.

The ages of the patients ranged from 17 to 59 years. Three were under 20 years

[1] Read before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

of age, 15 were between 20 and 29 years of age, three were in the 30- to 39-year group, and three were over 50 years old.

In 19 of the 24 patients, only one lung was involved by the tuberculous process. In 14 of these the lesion was limited to the right lower lobe and in five to the left. In five patients lesions were found in the lower lobes of both lungs, but even in this group the involvement was predominantly unilateral.

In 13 patients the initial symptoms were cough, expectoration, and fatigue, all of which appeared gradually and increased in severity as the lesions progressed. In nine instances the onset was acute; two of these had hemoptysis. In the remaining seven patients, the onset was characterized by an acute febrile reaction which simulated either grippe or pneumonia.

Tubercle bacilli were found in the sputum of all the patients. None of the group showed evidence of extra-pulmonary tuberculosis; three had diabetes.

Clinical Aspects.—In this survey, as in all others which have been reported to date, certain features of lower lobe tuberculosis are evident. These are the higher incidence among female patients, the more frequent occurrence in the right lower lobe, and the tendency for the involvement to be unilateral.

The symptoms and clinical course resulting from lower lobe tuberculosis are similar to those found in the usual upper lobe form. An important point of differentiation between these two forms of chronic pulmonary tuberculosis seems to be the rapidity with which lesions develop. Tuberculous lesions in the upper lobe as a rule develop slowly. Frequently they produce slight symptoms which may be present for many months before they become severe enough to cause the patient to seek relief. On the other hand, the symptoms produced by tuberculosis beginning in the lower lobes appear more abruptly, and, as a result of this, the patients usually present themselves for treatment earlier in the course of the disease. Even in those in whom the onset occurs insidiously with cough, expectoration, and fatigue, it is unusual to obtain a history of long standing symptoms.

In almost a third of the patients, the illness began suddenly with fever, sometimes preceded by a chill. The clinical picture in some instances resembled grippe and in others pneumonia. After a week or ten days, the symptoms became less intense and the temperature continued a degree or two above normal. Some cough and expectoration also remained. In several patients the resemblance to an acute infectious process was so marked that the specific nature of the condition was not recognized until suspicion was aroused by the persistence of the symptoms.

The pulmonary lesions in these patients were predominantly exudative and they developed with remarkable rapidity. A frequent occurrence was the development of large cavities during the short period in which the condition simulated an acute infection.

The physical signs varied with the extent and character of the lesion. In some cases, physical examination revealed very little in spite of extensive changes in the lung. In other individuals, especially in those in whom the onset was acute, bubbling râles indicating softening, and classical signs of excavation were found early in the course of the disease.

In the majority of cases tubercle bacilli were found in the sputum in the initial examination. In a few of the patients, in spite of the presence of large cavities and the production of a large amount of sputum, bacilli were found only after repeated examinations.

Roentgenographic Appearance.—There is no typical roentgenographic picture of lower lobe tuberculosis. The lesion is most frequently located either close to the structures at the root of the lung or in the upper third of the lower lobe. Unless the tuberculous process involves the entire lower lobe, extension of the lesion into the extreme base of the lung is rare.

Two distinct types of change are found. One is the result of infiltration and is seen

on the roentgenogram as a diffuse irregular density (Fig. 1). This resembles the changes produced by bronchiectasis, pneu-

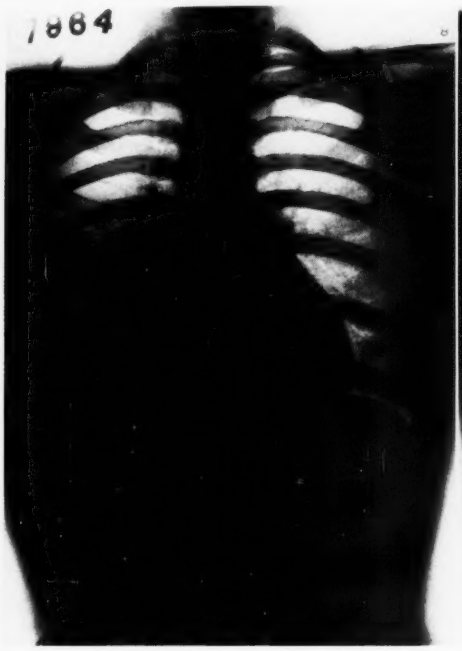


Fig. 1.

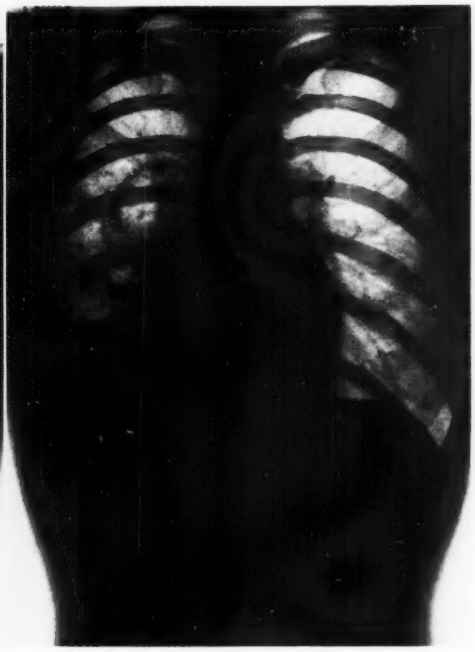


Fig. 2.

Fig. 1. Tuberculosis of the right lower lobe, in a female, aged 26. The diffuse area of increased density resembles that produced by non-specific infection.

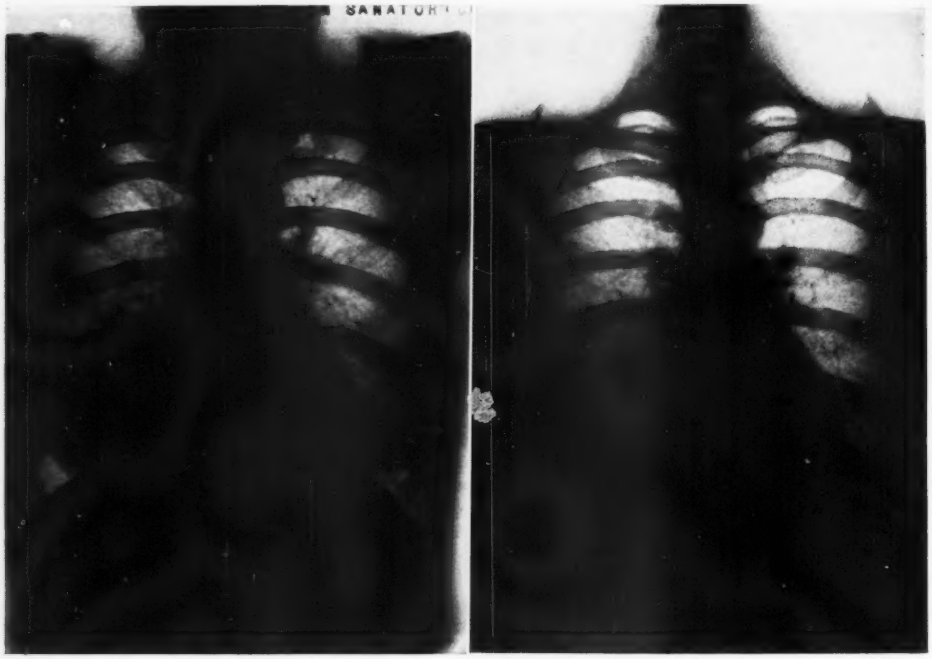
Fig. 2. Cavernous tuberculosis of the right lower lobe, in a female, aged 23. Important diagnostic features are the thin walled cavities, absence of fluid levels, and the absence of extensive changes in the surrounding lung tissue.

monitis, neoplasm, mycotic infections, or hemorrhage in the lung. The lesions may be located behind the heart and appear as a triangular shadow extending to the left of the heart with its base parallel to the diaphragm. These are similar to the triangular basal shadows described by Richards (9) and also by Anspach (10), which occur as the result of atelectasis and bronchiectasis. Unless distinct discrete tubercles can be seen among these shadows or in the area surrounding them, the exact nature of the lesions cannot be determined by roentgenographic study alone.

The second type is characterized by cavity formation (Fig. 2). The cavities usually occur singly but occasionally more than one is present. As pointed out by Gordon (11), these cavities are often thin walled, regular in outline, and frequently have no fluid level. In many instances the lung surrounding them is remarkably free from disease and as a result of this the cavity may stand out clearly in contrast to the rest of the well aerated lung. Lesions of this nature must be differentiated from abscess. The absence of marked inflammatory change in the lung surrounding the lesion is characteristic of cavitation as seen in primary lower lobe tuberculosis. In abscess, extensive inflammatory changes in the surrounding tissue are common.

Diagnosis.—The recognition of tuberculous lesions situated in the lower lobe of the lung may be exceedingly difficult. This is due, in part, to the similarity between the clinical and roentgenographic

aspects of this condition and those of other chronic pulmonary diseases, and, in part, to the fact that, in spite of extensive tissue destruction, examination of the sputum may fail to show tubercle bacilli.



A *B*

Fig. 3-*A* Tuberculosis in the right lower lobe in a female, aged 26. Cavity close to root area. Onset acute, with pneumonia-like syndrome. Artificial pneumothorax unsuccessful because no free pleural space could be found.

Fig. 3-*B*. Same patient as is shown in Figure 3-*A* after phrenic nerve operation. Note marked elevation of diaphragm and disappearance of cavity.

Many investigators are of the opinion that no lesion in the lower lobe of the lung can be called tuberculous unless tubercle bacilli are found in the sputum. However, Weidman and Campbell (7) believed that even if the sputum is negative, if there is a history of contact with tuberculosis and the symptoms and the roentgenographic appearance suggest tuberculosis, the lesion should be considered as such and treated accordingly. We agree with this view.

Careful investigation of the symptoms is of the utmost importance. In many of the patients the symptom complex is such that tuberculosis is suspected even though physical examination reveals no abnormalities in the chest. Cough, expectoration, and slight daily elevation of temperature are nearly always present. Two additional symptoms were found in the majority of the patients and, when present together, should direct suspicion to the character of the lesion. The first of these is fatigue. This is in the nature of complete exhaustion and differs from the fatigue caused by other diseases. It usually comes on during the late afternoon and disappears completely after the patient has rested for a short time. The second symptom which suggests tuberculosis is night sweat. This seems to be a fairly constant early manifestation of lower lobe tuberculosis. The sweats are not the severe variety seen in advanced tuberculosis, but are milder and

usually affect a limited part of the body, such as the neck and shoulders or the head. The combination of these symptoms with roentgenographic localization of changes in the lower lobe of the lungs should be considered presumptive evidence of lower lobe tuberculosis.

The importance of keeping tuberculosis in mind when dealing with chronic lesions in the lower part of the lung must be emphasized. Repeated examinations of the sputum for tubercle bacilli should be made in all patients having such lesions. If the sputum is negative, the patient should be examined bronchoscopically and the bronchial secretions removed during this procedure should be examined for acid-fast bacilli.

Treatment.—Because tuberculous processes which begin in the lower lobe are predominantly unilateral, collapse therapy is the treatment of choice. Of the 24 patients in this series, 18 were treated by this method. In 13 of these, artificial pneumothorax was induced, while in three others the pneumothorax was supplemented by phrenic nerve interruption. In the two remaining patients in whom no free pleural space was found, temporary phrenic nerve paralysis produced adequate collapse (Figs. 3-*A* and 3-*B*).

Despite the fact that induced paralysis of the diaphragm in the treatment of tuberculosis is regarded with disfavor by many clinicians at the present time, it is of definite value in the treatment of tuberculosis of the lower part of the lungs. As a result of this procedure, the force of the compressing agent, namely, the elevated hemidiaphragm, is exerted directly upon the diseased part of the lung, thereby affecting a variety of selective collapse. It is particularly beneficial in patients in whom the onset has been acute, since in this group there often is extensive obliteration of the pleural space which precludes the induction of artificial pneumothorax.

If the required amount of compression cannot be obtained by these measures, pneumoperitoneum may be instituted. Diaphragmatic elevation obtained by this method may be sufficient to exert a decided effect upon the diseased area.

If these more conservative measures fail to close the cavities, selective thoracoplasty may be performed as described by Freelander (12). This consists in the removal, in multiple stages, of all the lower ribs, beginning below and including the two ribs above the lesion.

Comment.—In the light of recent evidence, chronic pulmonary tuberculosis in which the lesions are limited to the lower lobes can no longer be considered a rarity. Most observers agree that lower lobe localization of the pathologic processes occurs in a small but significant percentage of tuberculous patients.

In some patients, certain features suggest that allergy to tuberculo-protein may be an important factor in the development of tuberculous lesions in the lower part of the lung. This is particularly true in those in whom the condition appears precipitously with an acute febrile reaction. In this group, violent systemic disturbance and necrosis in the lung with rapid cavity formation are probably manifestations of a high degree of tuberculin allergy.

SUMMARY

1. In a series of 1,405 tuberculous patients, 24 (1.7 per cent) had lesions which in the beginning were confined to the lower lobes of the lungs.

2. This variety of tuberculosis was found more frequently in women, the right lower lobe was most often involved, and, in most cases, the lesions were unilateral.

3. In this form of tuberculosis an acute onset and the rapid development of cavernous lesions are common.

4. Repeated examination both of the sputum and the bronchial secretions obtained directly through the bronchoscope may be necessary before tubercle bacilli are found.

5. The roentgenographic features are not characteristic.

6. Diagnosis is made primarily by the symptoms, localization of the lesion in the lower lobe, and sputum examination.

7. Because of the tendency of the process to remain unilateral, collapse therapy is the treatment of choice.

8. Allergy to tuberculin may be an important factor in the production of lower lobe tuberculosis.

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REFERENCES

(1) ASSMANN, H.: Ueber eine typische Form isolierter tuberkuloser Lungenherde im klinischen Beginn der Erkrankung. Beitr. z. klin. d. Tuberk., **60,** 527–539, 1925.

(2) FISHBERG, M.: Infraclavicular Tuberculous Infiltrations. Am. Rev. Tuberc., **17,** 1–21, January, 1928.

(3) DUFAULT, P.: Basal Pulmonary Lesions. Am. Rev. Tuberc., **25,** 17–23, January, 1932.

(4) REISNER, D.: Pulmonary Tuberculosis of Lower Lobe. Arch. Int. Med., **56,** 258–280, August, 1935.

(5) ROSS, E. L.: Tuberculosis in Nurses: A Study of the Disease in 60 Nurses Admitted to Manitoba Sanitorium. Canadian Med. Assn. Jour., **22,** 347–354, March, 1930.

(6) HAMILTON, C. E., and FREDD, H.: Lower Lobe Tuberculosis: A Review. Jour. Am. Med. Assn., **105,** 427–430, Aug. 10, 1935.

(7) WEIDMAN, W. H., and CAMPBELL, H. B.: Lower Lobe Tuberculosis. Am. Rev. Tuberc., **36,** 525–541, October, 1937.

(8) VIZWANATHAN, R.: Tuberculosis of the Lower Lobe. British Med. Jour., **2,** 1300, Dec. 26, 1936.

(9) RICHARDS, G. E.: The Interpretation of the Triangular Basal Shadows in Roentgenograms of the Chest. Am. Jour. Roentgenol. and Rad. Ther., **30,** 289–295, September, 1933.

(10) ANSPACH, W. E.: Atelectasis and Bronchiectasis in Children: A Study of 50 Cases Presenting a Triangular Shadow at the Base of the Lung. Am. Jour. Dis. Child., **47,** 1011–1050, May, 1934.

(11) GORDON, B.: Basal Pulmonary Tuberculosis. Internat. Clin., **1,** 67–77, March, 1936.

(12) FREELANDER, S. O.: Selective Thoracoplasty for Persistent Basal Tuberculous Cavities. Jour. Thoracic Surg., **7,** 455–457, April, 1938.

GROUP X-RAY SURVEYS IN APPARENTLY HEALTHY INDIVIDUALS[1]

By ARTHUR B. ROBINS, M.D., Supervisor of Clinics, *and* DAVID E. EHRLICH, M.D., Supervising Roentgenologist, Bureau of Tuberculosis, Department of Health, *New York City*

THE basis of effective tuberculosis control is a sound case-finding program. Such a program must meet certain fundamental requirements. First and foremost, it must result in the discovery of an increasing proportion of the estimated number of cases of tuberculosis in the community. Second, it must lead to the finding of the majority of these cases in the minimal stage of disease. If this latter aspect of the program is not realized, the effectiveness of the treatment facilities of the community, as Drolet (1) has so strikingly shown, will be sharply limited. Not only are we unable to cure a large proportion of the advanced cases of tuberculosis, but we cannot protect society from them, for, at the time they are first discovered, they have already disseminated their disease. The Bureau of Tuberculosis of the Department of Health, of New York City, has always accepted a case-finding program with these dual objectives as its primary responsibility.

Until recently, we, in common with other similar organizations, faced this problem solely in the traditional manner. We set up a city-wide system of district clinics, which examined a steadily increasing number of individuals annually. These facilities were confined to the study of those persons referred to us because of a history of contact with tuberculosis or symptoms suggestive of the disease. Every requirement for the adequate investigation of these cases has been met. Each clinic has been staffed by trained chest specialists. X-ray and sputum examinations have been made available to all of our units. A routine calling for the use of these diagnostic aids in every patient over 15 years of age and the graded tuberculin testing of every child under the age of 15, with x-ray examination of all positive reactors, has been in effect. Our generalized district nursing service has been trained to refer all suitable individuals to us, and private physicians have been encouraged to use our facilities for their patients freely. All contacts have been periodically re-examined and re-x-rayed. Through these efforts, in 1937, we examined more than 45,000 individuals and made over 70,000 chest x-ray films in our regular clinics. Yet we failed to satisfy our second criterion for sound case finding, as less than half of the new cases of tuberculosis were discovered in the minimal stage of the disease.

It has become steadily more apparent that the failure to find early cases lay in the method, and not in its execution. Examination of contacts and suspects was not enough. Cases discovered in this group were more apt to be in the advanced than the minimal stage of the disease. If early tuberculosis were to be found, we must look for it among those without history or symptoms—the apparently healthy population.

In 1933, the opportunity for a study of this type first presented itself. Through the co-operation of the State Temporary Emergency Relief Administration, the Association for Improving the Condition of the Poor, the Milbank Memorial Fund, and the National Tuberculosis Association we were able routinely to examine by x-ray more than 20,000 individuals on home relief, in New York City. These studies have been previously reported by Barnard (2) and Downes (3) and will not be discussed in detail here. These investigators found 2,047 new cases of pulmonary tuberculosis, at least half of which were clinically significant. Most of the others were in need of continued super-

[1] Read before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

vision. Most important of all, about 75 per cent of the cases were discovered in the minimal stage of the disease. With the co-operation and assistance of the WPA, we have steadily extended our activities in this field. At the present time, it is a definite part of our case-finding program, occupying an increasingly more prominent place in our work. This paper is an analysis of the examination of over 73,000 apparently healthy individuals routinely x-rayed during the twenty months from January, 1937, to September, 1938.

When these group examinations were started, our first problem was the choice of a method. Certain requisites had to be met. The procedure must accurately diagnose tuberculosis in the minimal stage, which can be done only radiologically; it must be adapted to the rapid examination of large numbers of individuals; it must be possible to carry out the studies in central locations, such as schools, institutions, or clinics, and to move readily from one location to another; the results must be of good technical quality, readily capable of interpretation and review, and the cost must be low.

Several methods were considered. These included tuberculin test screening, fluoroscopy, x-ray examination on celluloid film, and the rapid roll-paper method.

Tuberculin test screening was rejected because of the difficulty of securing permission for injection, the necessity for several visits by the patient, and the failure to detect non-tuberculous conditions. In the groups of older individuals, 50 per cent or more are positive and, therefore, tuberculin test screening is of little value. Fluoroscopy had the disadvantages of being incapable of review and of doubtful accuracy, technically, and was difficult to utilize in large groups in short periods of time. X-ray examination on celluloid film with stationary or portable equipment was limited in the rapidity with which large numbers of persons could be examined; and, it was too costly. Only the roll-paper method satisfied all of our requirements and it was adopted. We have continued to use it in this type of work and have found it completely satisfactory in over 100,000 group x-ray examinations done during the past five years. All of the material presented in this paper is from surveys performed by this method.

Our next problem was the choice of the groups to be studied. We were guided in this by several principles which we considered essential to sound tuberculosis case finding. The most important was to look for tuberculosis where one would expect to find it. Second, the groups studied should be such that the discovery and subsequent treatment of the afflicted individuals will materially aid in the protection of other members of the community. In choosing our groups, we were guided by mortality and morbidity statistics on the incidence of tuberculosis by age, sex, race, and economic status. Many of our surveys were sampling studies, done in an attempt to determine which groups would satisfy our requirements. Among those so examined were pre-adolescent children, high school and university students, applicants for employment in the Health and Fire Departments, persons suffering from venereal disease, homeless and non-settled males, prisoners, and the population on home relief in certain sections of New York City. Some of these groups were unproductive, and we have not continued mass examinations among them. The four groups to be discussed—the high school students, the home relief population of Harlem, the prisoners, and the homeless males—have been selected because they illustrate many basic features of this type of work and present findings of particular interest and significance.

The other major problem that confronted us was the adequate care and follow-up of the cases discovered. The first step was accurate diagnosis and classification. All survey films were read by a group of trained chest specialists who selected and classified the cases with lesions. Since December, 1937, this has been done uniformly in accordance with an x-ray code specially designed for the purpose. The

positive films were reviewed by members of the supervisory staff of the Bureau, all of whom have had considerable experience in interpreting chest films, under the guidance of one of the authors (D. E. E.).

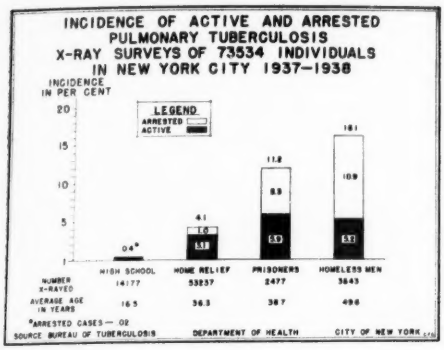

Fig. 1.

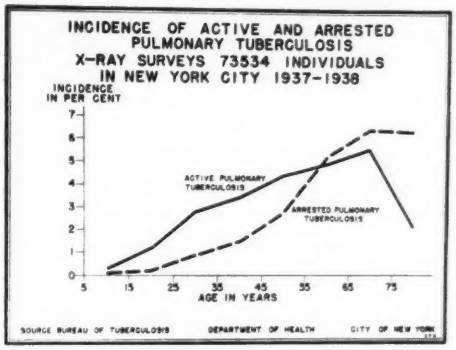

Fig. 2.

The cases in which a tentative diagnosis of tuberculosis was made were then checked against the Central Record File, a roster of all known individuals with tuberculosis in New York City. In this way the cases known to be under medical care were eliminated. Our efforts were centered on the residuum, the new cases of tuberculosis. In the preparation of the survey identification cards, it had been determined which individuals were under the care of a private physician. Those who had so indicated were referred back to their own doctor for future supervision, and a detailed report of our findings and recommendations was sent him. The individuals who were unable to afford private medical service became our responsibility. We attempted to determine the clinical activity of these cases by detailed observation, using physical examination, sputum tests, and serial x-ray study. The patients with active lesions were hospitalized in one of the city tuberculosis institutions, and the prisoners were treated on the tuberculosis service of the Correction Hospital. The patients with lesions of doubtful or low grade clinical activity were referred to our district clinics for periodic observation. Those persons with healed lesions were discharged. A complete analysis of the distribution of active and inactive tuberculosis in the groups examined is presented in Figure 1. In the course of this tuberculosis case-finding study, many other conditions were encountered. These included abnormalities of the lungs, pleura, heart and great vessels, mediastinum, and diaphragm. The incidence of these lesions and of certain congenital anomalies and of normal variants was determined.

High School Groups.—Our first group, the high school population, was composed of 14,177 individuals from four institutions. In *A*, a girls' school in Harlem, with a 43 per cent Negro enrollment of low economic level, not quite 2,300 pupils were x-rayed in two studies. In *B*, a boys' school, with a predominantly Italian enrollment of a higher economic level than *A*, 1,900 pupils were examined. In the third school, *C*, located on the lower East Side of New York, 5,200 boys and girls were x-rayed. Those examined in this school were almost equally divided by sex, the males constituting 53 per cent of the total. The students were predominantly Jewish and of a higher economic level than those in school *B*. In school *D*, 4,800 boys were x-rayed in two studies. These boys were drawn from all races and all parts of the city, and their economic status was the highest of any group represented. Forty per cent of school *A*, and 90 per cent of schools *B*, *C*, and *D* were x-rayed.

Tuberculosis in the high schools presented a less serious problem than we had anticipated. In our group of over 14,000 pupils, 52 cases of chronic pulmonary tuberculosis were found—a rate of four cases per thousand. Three of the 52 were discovered to be previously known cases of tuberculosis, and were classified as arrested. The majority of the cases were found among older students, more than three-fourths occurring in pupils over the age of 16 years. Striking differences were also noted in the distribution by sex. Only 25 cases were found among the boys, the remaining 27 cases occurring in girls. As the boys constituted 70 per cent of the entire group x-rayed, the rate in females was 2.5 times that in males. A similar disparity was noted in racial distribution. The Negro students represented only about 10 per cent of the entire group, yet contributed almost 25 per cent of all the cases discovered. Most striking, however, was the variation in rate in relation to the economic level of the school population. School *A*, with a large Negro enrollment of low economic level, had a rate of eight cases per thousand. School *D*, with students from the relatively highest income group, had only one case per thousand. The other two schools, *B* and *C*, fell halfway between the two extremes in both economic status and incidence of tuberculosis. A recapitulation of these findings is shown in Table I.

Thirty-five of the new active cases of tuberculosis were in the minimal stage, twelve in the moderately advanced stage, and only two in the far advanced stage of disease. Interestingly both of the far advanced cases occurred in Negro girls. Most of these individuals have been placed under treatment, either with their own private physician or in municipal tuberculosis institutions.

The incidence of healed primary tuberculosis was also determined. Calcification in the parenchyma or hilar region was considered evidence of primary infection. We have not undertaken a detailed analysis of our findings as only single postero-anterior films were employed, but in the entire high school group approximately 5 per cent showed such shadows. No cases with soft lesions suggestive of active primary infection were encountered. It is of interest that in approximately 6,000 cases receiving a tuberculin test with 0.1 mgm. of old tuberculin and an x-ray film made simultaneously, less than 1 per cent showed calcification in the absence of a positive Mantoux reaction.

With the exception of abnormal cardiac silhouettes, little else of importance was found in the routine survey of the high school group. Ninety-nine students presented a cardiac outline of abnormal configuration, an incidence of 0.7 per cent. On further investigation, many of these cases were found to be of no clinical significance, and some gave a history of previous cardiac disease. A certain proportion were previously undiagnosed cases of cardiac pathology and these were referred for medical care. Other pathologic conditions of the lungs, such as pneumonia and bronchiectasis, and disorders of the bones and mediastinum were so few as to be of slight significance. The incidence of these conditions, and of congenital anomalies is shown in Table II. Among the latter are included anomalies of the ribs, dextrocardia, eventration or hernia of the diaphragm, and accessory lobes of the lung.

Home Relief Population.—Our next group, the largest examined in these surveys, was drawn from the home relief population of Harlem. Harlem was chosen for this study of people on Home Relief because its inhabitants are predominantly Negro and Porto Rican, the races with the highest tuberculosis mortality in New York. Living conditions in this area of the city are bad, overcrowding and malnutrition being common, not only among the Negro population but among the whites as well. For these reasons we felt that a survey of this group would satisfy the principles in sound case finding of looking for tuberculosis where you expect to find it, and where its discovery will materially

aid in the protection of other members of the community.

During the 18-month period from Dec. 15, 1936, to May 15, 1938, 53,237 individuals were x-rayed. The average age of the entire group was 36.3 years, and 67 per cent were between the ages of 23 and 50. Forty-two per cent of the population was male, and 58 per cent female, and there was no significant difference in the average age of the two sexes. Approximately 37,000 Negro and 9,800 white persons were included in the survey. The remaining 6,500 individuals were classified as "race unknown," and were of mixed extraction. A large part of the white population and almost all of those of unknown race were Porto Rican.

Among the 53,000 individuals examined, 2,159 cases of chronic pulmonary tuberculosis were found, an incidence of 4.1 per cent. Three-fourths of the new cases of tuberculosis were active, the remainder arrested. The morbidity rate in males was 5.2 per cent, in females 3.2 per cent, but more arrested cases occurred among the males. The incidence of tuberculosis in men begins to rise from a rate of 3.3 per cent at the age of 20, and increases steadily to a maximum of 10.7 per cent at the age of 65. This is not due entirely to an increase in the proportion of arrested cases in the older age groups, as the same rise with age is noted if only active tuberculosis is considered. No such increase in incidence of tuberculosis with age is observed in women, the rate ranging from 2.6 to 5.1 per cent, with the percentage of active tuberculosis remaining between 2.2 and 3.4 per cent.

INCIDENCE OF PULMONARY TUBERCULOSIS X-RAY SURVEY OF FOUR HIGH SCHOOLS IN NEW YORK CITY 1937—1938

SCHOOL	TOTAL NUMBER X-RAYED	SEX	RACE	NUMBER OF CASES	PER CENT
A	2265	FEMALE	WHITE — 54.9% NEGRO — 41.1%	18	08
B	1909	MALE	WHITE — 94.3% NEGRO — 5.7%	8	04
C	5233	MALE — 53.4% FEMALE — 46.6%	WHITE — 99.1% NEGRO — 0.5%	21*	04
D	4770	MALE	WHITE — 94.5% NEGRO — 4.4%	5**	01
TOTAL	14177			52***	04

*INCLUDES ONE ARRESTED CASE
**INCLUDES TWO ARRESTED CASES
***INCLUDES THREE ARRESTED CASES
SOURCE BUREAU OF TUBERCULOSIS DEPARTMENT OF HEALTH CITY OF NEW YORK

Table I.

INCIDENCE OF OTHER CONDITIONS IN PERCENTAGE X-RAY SURVEYS 73534 INDIVIDUALS IN NEW YORK CITY 1937—1938

GROUP	CALCIFIED PRIMARY LESIONS	ABNORMAL CARDIAC OUTLINES	OTHER LUNG PATHOLOGY	BONE PATHOLOGY	CONGENITAL ANOMALIES OF			
					BONES	HEART	DIAPHRAGM	LUNGS
HIGH SCHOOLS	5.1	0.7	0.6	0.9	1.4	0.1	0.4	1.4
HOME RELIEF	5.0	2.4*	0.7*	2.8*	1.6*	0.1*	0.2*	1.2*
PRISONERS	9.5	7.6	4.2	6.0	1.2	0.4	0.4	1.5
HOMELESS MEN	16.4	3.9	5.4	11.0	2.9	0.6	0.1	1.9

*BASED ON 16960 EXAMINATIONS
SOURCE BUREAU OF TUBERCULOSIS DEPARTMENT OF HEALTH CITY OF NEW YORK

Table II.

Five hundred and eighty-two cases were discovered in the white population, of which 448 were active, and 1,321 cases in the Negro population, 982 of which were active. The ratio of active tuberculosis in the two races was 4.5 per cent in whites to 2.7 per cent in Negroes. When the racial groups were further divided by sex, a more striking difference was discovered. The incidence of active tuberculosis in white males was 5.7 per cent, in white females 3.3 per cent. The incidence in Negro males was 3.4 per cent, and in Negro females 2.2 per cent. The percentage of arrested tuberculosis in the four groups varied from 1.8 in white males to 0.8 in Negro females (Table III). The Porto Ricans of mixed racial stock showed an incidence of tuberculosis between that of the white and Negro populations throughout the series.

Seventy-three per cent of the active cases of tuberculosis were in the minimal stage, 16 per cent in the moderately advanced stage, and 8 per cent in the far advanced stage of disease when discovered. In males the incidence of minimal lesions was 69 per cent and in females 78 per cent. In all four subdivisions by race and sex more than 64 per cent of the lesions were

minimal in extent, and the percentage of far advanced tuberculosis did not exceed 12 per cent. Hospital care was provided for a large proportion of these patients, and many others were referred back to their private physicians for future supervision. The majority are being observed in our clinic service.

Evidence of healed primary tuberculosis was found in 5.0 per cent of all the persons examined. No significant changes in the distribution of these lesions by age, sex, or race were noted.

In a series of 16,960 individuals consecutively x-rayed, a record of the occurrence of certain non-tuberculous conditions was kept. The most important of these were abnormal cardiac silhouettes.

Cardiac outlines suggestive of organic disease of the heart or aorta were found in 407 (2.4 per cent) of all cases, and were present in almost equal ratio in males and females. The distribution of this finding by age was almost identical in both sexes. The incidence of abnormal cardiac silhouettes rose in the early years to a peak in the age group from 25–30, following which there was a slight fall. A more gradual secondary rise then occurred which was continued throughout the later years of life. The curves for the Negro population conformed to this general pattern exactly. The number of cases in the white population was too small to be plotted by age distribution. Seventy per cent of the lesions occurred in Negroes, and 30 per cent in whites.

Non-tuberculous lesions of the lung, such as bronchiectasis, pneumoconiosis, neoplasm, marked fibrosis, and pulmonary emphysema, were found in 133 cases. Sixty-seven occurred in males, and 66 in females, an incidence of 0.8 per cent in both sexes, which varied little between the Negro and white populations. The majority of these lesions occurred in individuals over 40 years of age.

Abnormalities of the bones, such as fractures, post-operative changes, and scoliosis, were observed in 482 cases, or 2.8 per cent of all those x-rayed. The majority of these occurred in males, and in individuals over 40. The incidence of these conditions was higher in the white population.

Congenital anomalies of the bones, principally fused, forked, cervical, and rudimentary ribs, were present in 279 persons, or 1.6 per cent of the entire group. Two cases of dextrocardia and 38 cases of eventration or hernia of the diaphragm were also detected. Two hundred and fourteen individuals had anomalous fissures of the lungs, 32 of which were due to azygos lobes and the remaining 182 to inferior accessory lobes. The incidence of the fissure of the azygos lobes was 0.2 per cent (Table II).

In this study an attempt was made to determine the frequency with which the fissure between the upper and middle lobes of the right lung appears on the x-ray film of apparently healthy individuals. It was clearly visible in 5,172 cases, or 30 per cent of all roentgenographs taken in the study, and we regard it as a normal variant and not an evidence of previous inflammatory disease.

Prison Population.—Our studies of the prison population were carried out on about 2,500 individuals, approximately 2,000 of whom were males. The men were equally divided into two groups, the so-called "long termers" and "short termers." The "long termers" were, of course, men committed for more serious offenses, with prison sentences ranging from six months to three years. For the most part they were young men, the average age being 38 years, and three-fourths were white and native born. The economic status of this group varied considerably.

The "short termers" were men committed for less serious offenses—such as vagrancy and disorderly conduct—and their maximum sentence was six months. This group was older than the "long termers," averaging 43 years in age. Almost 80 per cent were white, and slightly more than half were native born. The "short termers" came from the lowest economic stratum, many of them being vagrants with no means of support. The

women studied were all inmates of the House of Detention, and were serving indeterminate prison sentences. Their average age was only 32 years, and 60 per cent were Negroes.

INCIDENCE OF ACTIVE AND ARRESTED PULMONARY TUBERCULOSIS BY COLOR AND SEX—X-RAY SURVEY HOME RELIEF POPULATION IN NEW YORK CITY 1937-38

GROUP	NUMBER X-RAYED	NUMBER WITH TUBERCULOSIS			PER CENT WITH TUBERCULOSIS		
		TOTAL	ACTIVE	ARRESTED	TOTAL	ACTIVE	ARRESTED
WHITE MALES	5099	380	289	91	7.5	5.7	1.8
WHITE FEMALES	4791	202	159	43	4.2	3.3	0.9
NEGRO MALES	14444	645	494	151	4.5	3.4	1.1
NEGRO FEMALES	22481	676	488	188	3.0	2.2	0.8
TOTAL	53237*	2159*	1624*	535*	4.1*	3.1*	1.0*

*INCLUDES INDIVIDUALS WITH COLOR NOT SPECIFIED

SOURCE: BUREAU OF TUBERCULOSIS DEPARTMENT OF HEALTH CITY OF NEW YORK

Table III.

INCIDENCE OF ACTIVE AND ARRESTED PULMONARY TUBERCULOSIS X-RAY SURVEY OF PRISONERS IN NEW YORK CITY 1938

GROUP	TOTAL NUMBER X-RAYED	NUMBER WITH TUBERCULOSIS			PER CENT WITH TUBERCULOSIS		
		TOTAL	ACTIVE	ARRESTED	TOTAL	ACTIVE	ARRESTED
MALE PRISONERS	1992	262	141	121	13.2	7.1	6.1
FEMALE PRISONERS	485	16	6	10	3.3	1.2	2.1
TOTAL	2477	278	147	131	11.2	5.9	5.3

SOURCE BUREAU OF TUBERCULOSIS DEPARTMENT OF HEALTH CITY OF NEW YORK

Table IV.

In the analysis of our findings we have combined the results in the two groups of men, and will present them conjointly. In 1,992 male prisoners, 262 cases of chronic pulmonary tuberculosis were discovered, an incidence of 13.2 per cent. More than half the cases were clinically active, the remainder being classified, on the basis of further observation, as arrested. The greatest number of cases was discovered in men between the ages of 45 and 50 years, but the highest morbidity rate in any given five-year period occurred in the 65- to 70-year group. The white prisoners constituted almost 90 per cent of the cases and the Negroes only 7.6 per cent, although 22 per cent of the entire prison population was Negro. If only active tuberculosis is considered, eight cases were found in each 100 white prisoners to three discovered in a similar number of Negro inmates. A greater number of cases was discovered among the short term prisoners than among those committed for longer periods. This is presumably related to the fact that the former group were older and came from a lower economic level. The difference was less marked as regards the incidence of active pulmonary tuberculosis, many more of the lesions being arrested in the older men. A recapitulation of our findings in this group is shown in Table IV.

Fifty-seven per cent of the active cases found were in the minimal stage, 31 per cent in the moderately advanced stage, and less than 12 per cent in the far advanced stage of tuberculosis when first discovered. This distribution was little affected by age. Interestingly enough, of the 13 active cases in Negroes, 9 (70 per cent) were in the minimal stage, and only one had a far advanced lesion.

The incidence of shadows characteristic of healed primary tuberculous infection in this group was higher than in our previous studies. It was observed in 168 cases (8.4 per cent) of the entire prison population.

Abnormalities of the cardiac outline significant of organic disease of the heart or aorta were found in 157 cases—one of every 12 male prisoners x-rayed. The greatest number of cases was discovered in men between the ages of 45 and 50, the average age of those affected being 46 years. The same rate of abnormal cardiac silhouettes was found in white and Negro inmates, but whereas only 13 per cent of the white prisoners with heart disease were under 40, 50 per cent of the Negroes so afflicted were under this age. This is undoubtedly related to the greater prevalence of syphilis among the Negro population.

Pulmonary lesions other than tuberculosis were found in 5 per cent of the male prisoners. Included in this category were cases of bronchiectasis, pneumoconiosis, pulmonary fibrosis, and marked emphysema. As was to be expected, the majority of these lesions occurred in older men. Of the 100 cases of this type discovered, only five were found in Negro inmates.

The other conditions encountered in the course of this survey were of minor significance. One hundred forty-nine cases (7.5 per cent) of the population had abnormalities of the bony cage, three-fourths of which were old fractures of the ribs. Sixty-eight congenital anomalies were discovered, all but two of which were anomalous ribs or accessory lobes of the lungs (Table II).

The study of the 485 women prisoners at the House of Detention revealed a quite different picture. In this group 16 cases of pulmonary tuberculosis were found, of which six were considered clinically active. The total incidence of tuberculosis in women was 3.3 per cent, and of active disease only 1.2 per cent. The cases were too few in number to draw any significant conclusion as to age or color distribution. Five of the six patients with active disease had minimal lesions, and one was in the far advanced stage. Treatment for these patients was provided in a municipal tuberculosis institution.

Healed primary tuberculous lesions were noted in 13.8 per cent of the women.

Cardiac abnormalities were also less frequently found, but the difference between the sexes was less striking. Thirty-one cases with abnormal cardiac outlines were discovered, 15 in white and 16 in Negro prisoners. As in males, the majority of the cases in the white population occurred after the age of 40, and in the Negro population before that age. The disparity in age incidence in the two races was even greater than in male prisoners and is to be attributed to the relative infrequency of syphilitic heart disease in white females, and its not uncommon occurrence in Negro women.

Other conditions encountered in female prisoners were so few in number that no analysis will be given. They are combined with the findings in male prisoners under the common headings in Table II.

Homeless Men.—Our fourth group, that of homeless men, was chosen because the tuberculosis problem in these men is of the first magnitude. The division for Transient and Non-settled Males of the Department of Welfare, of New York City, has under its jurisdiction about 30,000 individuals annually. The great majority are residents of New York who have never established settlement by remaining continuously in the city for one year without receiving public assistance. Most of them spend only part of the year in the city, leaving during the summer months to engage in migratory labor. Others remain here constantly. Only a few are real transients with an established legal residence elsewhere. While in New York City the men receive assistance from the Department of Welfare in the form of board and lodging. The lodging consists of a bed in one of the municipal shelters or in a commercial hotel. During the day the men come and go, sitting in parks, visiting public buildings and places, and freely mingling with the rest of the community. From time to time many secure odd jobs, usually at food handling. Clinic supervision of this population is difficult, and medical care can be administered only in an institution. For these reasons the spread of communicable disease, and, in particular, tuberculosis, by this group is a major public health hazard.

With these facts in mind, several surveys of the homeless men were undertaken this year. Through the co-operation of the Department of Welfare, 3,643 men were x-rayed in three studies. Eighty-seven per cent of the group were white, and 12 per cent Negro. Although the average age of the entire group was 50, more than half of the white males were over this age, whereas almost four-fifths of the

Negro males were below 50. The cases of tuberculosis found numbered 586, an incidence of 16.1 per cent. One-third of the cases were considered active; the remaining two-thirds arrested. Of the 188 cases of active tuberculosis, 175 occurred in white males, and only 13 among the Negroes. The incidence of active tuberculosis in the white population was 5.5 per cent and in the Negro population 2.9 per cent, and the number of cases of tuberculosis found corresponded to the number of individuals of that race x-rayed in any age group. Of the arrested cases found, 97 per cent were in white men, and here the age distribution appeared to be the decisive factor, as the incidence of arrested tuberculosis increased steadily with the age of the men examined. All 11 arrested cases in Negroes occurred in men under 59 years of age, whereas only 55 per cent of the 387 arrested cases in whites were found in men below this age (Table V).

The distribution of the active cases of tuberculosis, by stage, followed the same general pattern as in other surveys. Forty-five per cent were minimal, 40 per cent moderately advanced, and 15 per cent far advanced in extent. Three of the 13 Negro males with active tuberculosis had far advanced lesions. A large proportion of the individuals with active tuberculosis were hospitalized on the wards of municipal tuberculosis institutions.

X-ray evidence of healed primary infection was found in one out of every six men examined, frequently together with a lesion of the reinfection type.

Abnormalities of the cardiac outline were noted in 142 cases, an incidence of 3.9 per cent. The ratio of impairment in whites and Negroes was about the same, but the rates at different ages varied considerably. Half of the Negroes with cardiovascular pathology were under the age of 49, while only one-sixth of the whites similarly affected were below this age. Tortuosities of the great vessels were commonly encountered in older men and were disregarded, only enlargement of the heart shadow and aneurysmal dilation of the aorta being recorded in this study. As a result, the incidence of cardiac pathology is low.

Other types of pulmonary lesions were present in 195 cases (5.4 per cent) of the group examined. The majority of these conditions occurred in older men, and were of little clinical significance.

Pathologic conditions of the bones were noted in 418 (11.5 per cent) of the films. More than half of these were healed rib fractures. In an additional 90 (2.5 per cent) of the cases, anomalies of the bones were present. Two cases of dextrocardia and five cases of eventration or hernia of the diaphragm were discovered. Anomalous fissures of the lung were found in 58 cases, an incidence of 1.9 per cent (Table II). In addition, a certain number of pathologic conditions of the soft tissues, foreign bodies, etc., were encountered. No tabulation of these findings has been made.

Discussion.—Before discussing tuberculosis in the entire population studied, we should like briefly to review our findings on non-tuberculous conditions, based on 37,257 x-ray examinations.

Abnormal configurations of the heart or aorta were found on the initial roentgenograph of 973 individuals, an incidence of 2.6 per cent. The frequency of this condition increased with the age of the group studied, irrespective of sex or race. Since in many of these cases subjected to a com-

INCIDENCE OF ACTIVE AND ARRESTED PULMONARY TUBERCULOSIS X-RAY SURVEY OF HOMELESS MEN IN NEW YORK CITY 1938

GROUP	NUMBER X-RAYED	NUMBER WITH TUBERCULOSIS			PER CENT WITH TUBERCULOSIS		
		TOTAL	ACTIVE	ARRESTED	TOTAL	ACTIVE	ARRESTED
HOMELESS MEN	3643	586	188	398	16.1	5.2	10.9

SOURCE: BUREAU OF TUBERCULOSIS DEPARTMENT OF HEALTH CITY OF NEW YORK

Table V.

plete cardiac study our findings were confirmed, and the age distribution of our cases closely parallels the accepted standards for the frequency of cardiac disease, it is our feeling that the results are of significance. The incidental finding of cardiac pathology in more than two out of every 100 apparently healthy persons x-rayed seems sufficient justification for the universal use of a roentgenographic method in a tuberculosis case-finding program in adults.

Pathologic conditions of the bones were discovered in 1,160 cases, 3.1 per cent of all persons x-rayed. The single most common type of bone lesion was healed fracture of the ribs which made up more than half of the bone pathology in the studies on prisoners and homeless men. Scoliosis was also frequently discovered, particularly in older individuals. A few cases with postoperative bone changes, cysts, and tumors of the ribs were also observed.

Of 37,257 individuals examined, 442 (1.2 per cent) had chronic non-tuberculous pulmonary conditions. The incidence of these lesions was greater in men and in older persons.

Congenital anomalies were found in almost 1,200 individuals. More than half such anomalies were bone conditions, such as fused, forked, cervical, and rudimentary ribs. The incidence of bone anomalies in the entire population examined was 1.7 per cent.

Six cases of dextrocardia, most of them with situs inversus, were found in 37,257 persons x-rayed, an incidence of 0.02 per cent. This agrees closely with the observations of Adams and Churchill (4), who found one case in 8,000 autopsies, at the Massachusetts General Hospital, and Guenther (5), who discovered three cases in 22,000 postmortems. This is considerably higher than the incidence discovered by clinical examination as reported by both these authors.

Eventration or hernia of the diaphragm was present in 51 individuals (0.14 per cent). Our incidence of this finding was almost three times that reported by Newcomet and Spackman (6) as an incidental finding in 17,000 chest and gastro-intestinal x-ray examinations.

Anomalous fissures of the lungs were observed in 526 cases (1.4 per cent) of all persons studied. The vast majority of these were produced by the inferior accessory lobe. In our largest study, we found 32 azygos lobe fissures in 17,000 films, an incidence of 0.2 per cent. This is considerably lower than the incidence of 0.8 per cent reported by Soper (7) but more nearly agrees with the estimates of Matter and Coope and Zanadowski quoted by Soper.

The most significant of our findings deal with the incidence and distribution of tuberculosis in over 73,000 apparently healthy individuals. In over 14,000 high school children, active tuberculosis was found in 0.4 per cent. This is in close agreement with most recent observations on the incidence of tuberculosis in the high school group (8, 9, 10). In one recent report (Hetherington, 11), an incidence of reinfection tuberculosis five times as high as that noted in our studies was found in 1,200 high school pupils. The difference between this figure and the findings in other studies was attributed to discrepancies in the interpretation of the film as well as geographic variations in the incidence of disease. Since the films in our surveys were read and reviewed by several chest specialists well acquainted with the significance of small, asymptomatic infiltrations in adolescents, we are inclined to attribute the differences almost entirely to geographic factors.

The incidence of 3.1 per cent active pulmonary tuberculosis in the home relief population is in close agreement with results previously obtained in New York City. In the studies of Barnard and Downes, already referred to, significant tuberculous lesions were found in from 1.5 to 3 per cent of the population. In a more recent study reported by Edwards (12), an incidence of 1.6 per cent active tuberculosis was noted. Surveys reported by Martin, Pessar, and Goldberg (13) and

Fellows (14) on selected groups of apparently healthy individuals have shown from 2 to 3.6 per cent with evidence of pulmonary tuberculosis.

The highest incidence of active tuberculosis was obtained in prisoners, 5.9 per cent of whom showed significant lesions. Since the prison sentence of this population was short, the high rate of disease among the men is to be attributed to their economic background and is not associated with their stay in the penal institution.

Confirmatory evidence of the importance of economic status and its attendant living conditions is furnished by the results of our surveys of homeless men. This older group existing at a bare subsistence level had the amazing incidence of 16.1 per cent tuberculosis, over 5 per cent of which was active. Grosfeld (15) has found almost identically the same incidence of active and arrested tuberculosis in a similar study in Paterson, New Jersey. Shurly and Brachman (16), in a study of 1,000 homeless, unemployed men, in Detroit, in 1935, found 6.5 per cent with tuberculosis, 2.1 per cent of which was active. The population studied by them was younger and may have had a better economic background.

The incidence of active and arrested tuberculosis by age, shown in Figure 2, follows the expected pattern. Active pulmonary tuberculosis occurs with steadily progressive frequency as the age of the population increases, reaching a maximum between the ages of 65 and 75. The incidence of arrested pulmonary tuberculosis increases slowly until the age of 45 is reached, then rising rapidly in the last four decades of life.

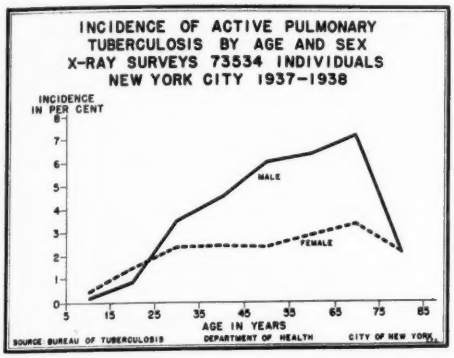

Fig. 3.

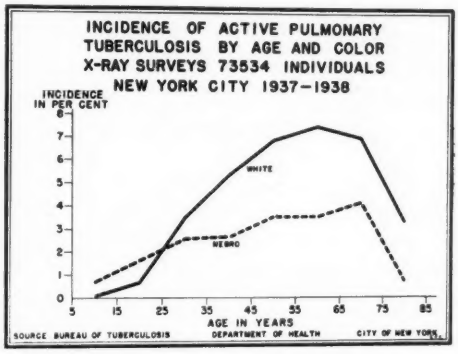

Fig. 4.

The distribution of active pulmonary tuberculosis by age and sex closely parallels the mortality curves for males and females in New York City. In men, the incidence of active pulmonary tuberculosis is low between the ages of 5 and 25 years, and then rises rapidly throughout the remainder of life. In women, the rise in tuberculosis morbidity is much sharper in the early years, exceeding the male rate prior to the age of 25, then reaching a more or less stationary level which is maintained throughout life (Fig. 3).

Figure 4, portraying the distribution of active tuberculosis by age and race, is most striking. Contrary to accepted beliefs, the incidence of active tuberculosis in the Negro population is considerably lower than in the white population. Not only is this characteristic of the home relief group in Harlem, where a large proportion of the white population is Porto Rican, but it is also true among prisoners and homeless men where the white population is not weighted by a preponderance of any one nationality. Only in the high schools where all those x-rayed were under the age of 25 years, is the rate in Negroes higher than in the whites. Other studies on smaller groups done in New York City (3) have

shown similar findings. On the other hand, mortality statistics in cities like New York, Detroit, and Chicago show a Negro tuberculosis death rate five to six times that of the white. We believe the explanation for this apparent paradox lies in the fact that the Negro population has undergone a process of natural selection because of the fulminating character of the disease in the race under the conditions of life in large cities. Acute pneumonic and disseminated forms of tuberculosis in young Negroes are responsible for the deaths and the hospital admissions (Pinner and Kasper, 17) but are not seen in mass x-ray studies of apparently healthy individuals. Minimal lesions, which constitute a relatively smaller percentage of all cases of tuberculosis in Negroes than in whites, are found by surveys. A recent study of the patients of the most active tuberculosis hospital service in New York City would seem to bear this out. Fifteen per cent of the hospital beds were occupied by Negroes who comprise only 5 per cent of the population of the city. It is our conviction that a true picture of tuberculosis in the Negro in large cities can be derived only by a consideration of the disease as it manifests itself both in hospital wards and mass surveys. Certainly, no impression based on mortality tables alone can be an accurate one.

Summary and Conclusions.—From this material, we have arrived at several conclusions:

1. Group x-ray examinations of apparently healthy individuals are a productive method of tuberculosis case finding and should be a part of the program of all large public health organizations.

2. In such studies the incidence of clinically significant pulmonary tuberculosis varies with the age, sex, race, and economic level of the population studied.

3. The incidence of active tuberculosis in Negroes is lower than in whites among the apparently healthy population.

4. The major portion of our efforts should be expended on adults and groups of low economic level.

5. The majority of the cases are discovered in the minimal stage of tuberculosis.

6. Abnormal cardiac outlines significant of organic disease of the heart or vessels are found in a sufficiently high percentage of cases to warrant the universal use of roentgenography.

7. In rapid examinations of large groups, the roll-paper method is the procedure of choice from the point of view of convenience, accuracy, and economy.

We wish to express our appreciation to Mr. Raymond Murphy, Chief Statistician of the Bureau of Tuberculosis, for his invaluable assistance in the collection and tabulation of the statistical data, and to Mr. Myron Heidingsfield, Consulting Statistician, for his helpful advice.

BIBLIOGRAPHY

(1) Drolet, G. J.: The Present Trend of Case Fatality Rates in Tuberculosis. Am. Rev. Tuberc., **37,** 125–151, February, 1938.

(2) Barnard, M. W.: The X-ray in Tuberculosis Case Finding. Quart. Bull. Milbank Memorial Fund, **11,** 1, 1933.

(3) Downes, J.: Tuberculosis Case Finding in the Red Hook Area of New York City. Quart. Bull. Milbank Memorial Fund, **12,** 1, 1934.

(4) Adams, R., and Churchill, E. D.: Situs Inversus, Sinusitis and Bronchiectasis: Report of Five Cases Including Frequency Statistics. Jour. Thoracic Surg., **7,** 206–217, December, 1937.

(5) Guenther: Quoted by Adams and Churchill (4).

(6) Newcomet, W. S., and Spackman, E. W.: Eventration and Hernia of the Diaphragm as an Incidental Finding. Radiology, **27,** 36–43, July, 1936.

(7) Soper, W. B.: Some Clinical Aspects of Accessory Lobes of the Human Lungs. Yale Jour. Biol. and Med., **5,** 227–234, January, 1933.

(8) Brachman, D. S.: Tuberculosis in the Adolescent. Jour. Michigan Med. Soc., **34,** 529–535, September, 1935.

(9) Barnard, M. W., Amberson, J. B., Jr., and Loew, M. F.: Tuberculosis in Adolescents: Study of 1,000 School Children in New York City Made under Auspices of Bellevue-Yorkville Health Demonstration in 1930. Am. Rev. Tuberc., **23,** 593–641, May, 1931.

(10) Edwards, H. R.: Reducing the Cost of High School Case Finding. Trans. Nat. Tuberc. Assn., **29,** 238, 1933.

(11) Hetherington, H. W., Israel, H. L., and Kreitz, P. B.: The Incidence and Control of Tuberculosis in High School Children. Am. Rev. Tuberc., **38,** 406–440, October, 1938.

(12) Edwards, H. R.: Twentieth Century Case Finding. Journal-Lancet, **58,** 156–160, April, 1938.

(13) Martin, D. Clifford, Pessar, H. T., and Goldberg, J. A.: A Tuberculosis Survey among 2,000 Food-handlers in New York City. Am. Rev. Tuberc., **29,** 182–189, February 1934.

(14) Fellows, H. H.: A Study of the Incidence of

Pulmonary Tuberculosis. Am. Rev. Tuberc., **30,** 109–113, July, 1934.
(15) GROSFELD, W.: Personal communication.
(16) SHURLY, B. R., and BRACHMAN, D. S.: Latent Sources of Contact in Tuberculosis. Am. Rev. Tuberc., **34,** 96–106, July, 1936.
(17) PINNER, M., and KASPER, J. A.: Pathological Peculiarities of Tuberculosis in the American Negro. Am. Rev. Tuberc., **26,** 463–491, November, 1932.

DISCUSSION OF SYMPOSIUM ON PULMONARY DISEASES

SYDNEY J. HAWLEY, M.D. (Danville, Penna.): To start with the paper of Dr. Ehrlich and Dr. Robins, this is one which deserves the attention of all of us upon three scores: First, as citizens; second, as doctors, and third, as radiologists.

We, as radiologists, are going to find ourselves assisting in these surveys for tuberculosis, as well as for other disease, more and more in the process of improving the health of the population, and I think it is exceedingly important for us to study a survey of this kind, which is so well done and so authoritative.

Certainly this review of 73,000 examinations is a valuable study and the figures which have been presented deserve our close attention and study. Numerous things can be elicited from looking at these figures; I am going to bring out only one. I would like to call your attention to the difference in percentage of tuberculous cases found in the high school groups and the percentage of such found in the home relief groups. If I remember the figures correctly, it was about ten times as high in the home relief group. I believe that we can make tuberculosis as rare as smallpox by discovering the cases early and removing contacts. That can be done by efficient and constant surveys, education of the population, as well as education of the medical profession, to the value of surveys and the importance of early treatment.

Dr. Sokoloff's paper is extremely valuable to all of us, calling attention again as it does to lower lobe tuberculosis. That is something which I am sure we all know exists but to which we do not all pay enough attention. I think that undoubtedly many cases of lower lobe tuberculosis are overlooked or incorrectly diagnosed because we do not realize that this condition is as common as it is. It was not many years ago that I heard a distinguished radiologist say that he had never seen a case of primary lower lobe tuberculosis. I think he was sincere, but mistaken. Undoubtedly he had seen but not recognized them. The bronchoscope can be of great aid in diagnosis. I feel that any patient with a lower lobe lesion should have a bronchoscopy. Obtaining a specimen of the secretion by bronchoscopy will often reveal tubercle bacilli when they will not be found in sputum obtained in the ordinary manner. I would like to re-emphasize Dr. Sokoloff's statement that lower lobe tuberculosis does not have any characteristic appearance. That must be remembered in interpreting lesions found in the lower lobes.

The last paper deserves our very serious consideration. Radiology has contributed a great deal to the increased accuracy of diagnosis of lesions of the chest and I doubt if there is any field in which radiologists are as self-confident as in the interpretation of chest findings. Studies such as Dr. Farrell[1] has made will teach us much about the accuracy of our own opinions in the interpretations of chest findings.

I think Dr. Farrell is too critical of himself, because I believe some of the cavities of which he spoke probably could never be visualized as they were filled with fluid at the time of examination. A tumor of the bronchus obstructing the bronchus may cause a breakdown with a large destroyed area in the lung filled with pus, undistinguishable by any method on the roentgenogram.

Some of the errors, however, might be eliminated, or limited by the use of oblique and other positions with the use of the Bucky, which Dr. Farrell mentioned.

One thing his study points out clearly and which is quite important for us to recognize, is the difficulty in making a differential diagnosis on an x-ray film of silicosis, tuberculosis, or metastasis. It is easy in cases in which you know there

[1] Not received for publication.

has been exposure to dust, especially dust containing silica, to presume that the visible shadows are silicosis. This we must guard against, since it will lead us frequently into prescribing improper treatment for the patient, and perhaps cause medico-legal difficulties.

Studies like Dr. Farrell's are of great value in helping us to eliminate such errors. Serial studies are of great importance.

One thing which he did not bring out distinctly in his paper was the question of the correlation of the autopsy findings and the changes found in silicosis and the changes found in the clinical picture of the patient with silicotic infiltrations. The whole story on this subject is not yet written. There is often a discrepancy among the clinical appearance, the x-ray appearance, and the autopsy findings. This subject needs to be worked out, and it is studies such as Dr. Farrell has started which will put us on the right track.

LEO G. RIGLER, M.D. (Minneapolis, Minn.): I would like to echo what Dr. Hawley has just said about the importance of the survey which Dr. Ehrlich and Dr. Robins presented. I have been interested in survey work for many years and there are a few points I would like to bring out.

It is particularly interesting to note that they rejected the tuberculin testing as a means of screening. Personally, I am inclined to agree with that for reasons in addition to those which they presented. I think this is a courageous thing to do in view of the present sentiment on the subject.

I hastily jotted down some figures which they presented, yet I may be wrong in some of them because I did not have an opportunity to study them before, but I was interested in the rather low percentage of tuberculous cases reported in the high school group, considering the economic status of the pupils and considering that it is an urban population. It seemed to me that that figure was rather low.

At our University, in a relatively rural community and among a group of students on a much better economic level, I am sure, than those reported in this survey, the incidence of tuberculosis found is about the same. They are slightly older, it is true, but the incidence should be less, I would think.

Another point that seems to me of considerable interest—and both of these bear on the points I wish to make—is the incidence of accessory lobes which was discovered during the course of this survey, which I understood was something over 1 to 1.5 per cent. We found, in a survey of University students, again, that we could demonstrate inferior accessory lobes in about 8 per cent of all the films.

I am interested in that because I recently had opportunity to compare film with x-ray paper and was impressed there also with the fact that such things as the fissures between the middle and upper lobes or accessory lobe fissures were much more brilliantly demonstrated in the film than they were in the paper.

I raise this question, as to the incidence discovered of tuberculosis in high school students and also as to the incidence of fissures merely by way of inquiry as to whether that low incidence might not be due to the fact that paper was used in this survey. I can understand thoroughly the advantages of paper under such circumstances, and it is a serious question as to whether or not the amount that might have been overlooked outweighs the advantages. I do think that these two comparative figures should make us think a little as to whether or not the paper was fulfilling the purposes of the survey to the fullest extent.

Dr. ROBINS (*closing*): Dr. Rigler has asked several rather difficult questions; I shall try to answer them.

First of all, about the incidence of tuberculosis in the high schools. If you looked at the chart carefully, you saw that the incidence ranged from one-tenth to eight-tenths of 1 per cent, depending upon the economic status. If we had divided

our cases according to age group, we would have found considerably higher percentage than that found in students over the age of 16. The average age of the entire group was 16.5 years and 50 per cent of the cases were over that age and a similar number under that age. Three-quarters of the cases of tuberculosis we found were in the older age group, which would materially alter our incidence of tuberculosis.

We have also worked in slightly older age groups which are probably comparable to the ones Dr. Rigler referred to. Our applicants for employment in New York City in the Fire and Health Departments are, for the greater part, young men and women between the ages of 21 and 30 years. The upper age limit for the Fire Department is 30 years, I believe. In that group, all of whom had been carefully examined medically and had passed through the rather rigorous physical tests for the Fire Department, who were x-rayed on paper film initially, we found 2 per cent with chronic pulmonary tuberculosis, 1.3 per cent of which was clinically active.

We have tested paper film in several ways. In 1932 we did a study of a thousand consecutive individuals x-rayed on paper and celluloid routinely at the same time. All of these films were read by Dr. J. Burns Amberson, Jr., in New York City, who failed to find any significant difference in the incidence of lesions in the two groups on paper or celluloid.

We make it a practice to check all of our suspicious and definite cases on celluloid film and we have failed to find very much difference in our opinion of the case on paper and celluloid film.

I think some of the recent technical studies, in particular the demonstration of the Moore School which is going on now, provide a fair indication of the relative comparison of the two media in all types of cases.

Hence I cannot agree with Dr. Rigler that we missed tuberculosis by use of the paper film. I cannot prove it, perhaps, but we have not yet in any series of comparison studies had any evidence to indicate it.

As regards the incidence of inferior accessory lobes, there, I think, we are on a little different ground. I agree with Dr. Rigler that they show up a little more brilliantly on the celluloid than on the paper film. However, taking the fissure between the right middle and the right upper lobe, which I think is even a better test of detail in the paper film, we were able to find it in 30 per cent of our cases in one carefully controlled study, and in some others in which we paid particular attention to it we found it in even a higher percentage of cases. I think that is fairly good evidence of the degree to which the detail in the film will reveal as fine a shadow as the hairline between the right upper and right middle lobe.

Just what the difference in the incidence of inferior accessory lobes is due to, I am not prepared to say. I think there, again, it depends to a great extent upon just how seriously it is looked for. We did find it in about 1.5 per cent.

Whether there are other factors such as the race and age and sex of the population that might affect the incidence of inferior accessory lobes, I am not prepared to state. I do not know, but I really cannot believe, in all sincerity, that the differences are due to the media primarily.

DR. FARRELL (*closing*): There is this to be said about the formation of cavities, if I may discuss the discussant's discussion: I have wondered sometimes if these cavities which we missed were really not cavities which developed at postmortem. I mean by that, that as soon as the lung is incised, often one finds in the center of these anthraco-silicotic masses soft, mushy, necrotic tissue which falls out on section of the lung and, of course, the pathologist calls that a cavity. I am wondering if that really was not a postmortem development of the cavity rather than an antemortem cavity.

I think I can again emphasize the importance of serial studies in cases of silicosis of all varieties in which there is a question of complicating tuberculosis.

TREATMENT OF CARCINOMA OF THE RECTUM BY ELECTROCOAGULATION AND RADIATION, IN SELECTED CASES[1]

By HYMAN I. TEPERSON, M.D., Attending Radiation Therapist, Beth El Hospital; Brooklyn Cancer Institute (Ira I. Kaplan, M.D., Director); Brooklyn Women's Hospital, and Brooklyn Hebrew Hospital for Aged, *Brooklyn, New York*

SLIGHTLY more than 5 per cent of all malignant lesions occur in the colon, and the majority of these are located in the terminal four and one-half inches and within reach of the examining finger. This type of carcinoma occurs most often between the ages of 40 and 70 years, but cases have been known to occur as early as at the age of 10 years.

The preponderant occurrence of neoplasms at points of fixation in the colon strongly suggests that irritation is a major causative factor. However, no definite predisposition can be proven except in cases arising from multiple polyposis in which it must be assumed that an abnormality previously existed at the site of the polyp formation. As yet no satisfactory evidence has been adduced that carcinoma develops in tissues altered by the presence of hemorrhoids, fistulæ, or cicatrices.

Clinically, three types of growth are encountered:

1. The polypoid or protuberant growth, which is movable and ulcerates superficially.
2. The flat crater-like excavated growth with indurated base, and margins which are elevated and nodular.
3. The annular growth with superficially ulcerated surface.

Seventy-five per cent of these neoplasms appear on the anterior wall of the colon. The onset of the disease is insidious; the patient commonly complains of increasing constipation, pain in back or bowel, or has noticed the appearance of blood-stained stools. These three symptoms are present in 85 per cent of all cases of carcinoma of the rectum. Occasionally, tenesmus, a slight discharge from the rectum, dysuria, and ribbon-like stools are also present. Secondary symptoms such as emaciation, cachexia, and anemia appear late and usually follow the absorption of toxins, from an associated proctitis present in the region immediately proximal to the site of the tumor.

From the time of appearance of the first symptoms, an average of twelve months elapse before patients with carcinoma of the rectum apply for treatment and, although the disease is slow growing, the process is, by that time, usually fairly well advanced. Glandular metastases are present in a large percentage of cases and the colon may be fixed by extension of the process to adjacent tissues. It is such conditions, resulting from delay, which make the treatment of carcinoma of the colon rather difficult.

Once the diagnosis is established, the elimination or destruction of the disease process must be next considered.

It is the consensus of opinion that if a malignant tumor has remained local, and none of the cells has either infiltrated or metastasized to adjacent or distant structures, then complete surgical extirpation offers the greatest likelihood of cure. Those patients in whom radical surgery can be carried out with reasonable promise of success are classed as operable. Under these conditions, only from 30 to 70 per cent of patients are operable, depending upon the ability and boldness of the surgeon.

Of those operated upon, 40 per cent have lymph node involvement at the time of operation. Not all these nodes are malignant, but many are, and these militate against the ultimate success of radical surgery in such cases.

In patients with advanced lesions with

[1] Read by title at the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28-Dec. 2, 1938.

definite metastases to lymph nodes and viscera, radical procedures are useless and palliative therapy is all that can be offered. Colostomy in such cases alleviates an existing obstruction but does not prolong the life of the patient. But even in this type of case many obstructive growths in the rectum may be removed by electrocoagulation with immediate relief, obviating the necessity of a colostomy.

There is another intermediate group of individuals in whom the disease has remained more or less local, depending upon the amount of fixation and local extension, but, because of associated debilitated state, advanced age, or the presence of cardiac, renal, or diabetic disease are poor risks for radical surgery. It is in this group that treatment by electrocoagulation and radiation offers its greatest usefulness.

There are practically no contra-indications to this method so that any patient whose tumor is accessible through the anal orifice may receive the benefits of such treatment.

Procedure.—In carrying out this method of treatment, the patient requires very little preparation. A cleansing enema is given a few hours before the operation, and spinal, caudal, or local anesthesia may be employed.

Spinal anesthesia gives complete satisfaction, but if caudal anesthesia is used, an injection of from 40 to 60 c.c. of 1 per cent novocaine solution is injected between the sacrum and coccyx about the cauda equina. In this way post-operative headaches are avoided.

Local anesthesia may be used if a small growth is to be removed. The anal sphincter and the surrounding tissues are infiltrated with a 2 per cent solution of novocaine, and while pain is eliminated the sensation of heat is retained by the deeper structures. The patient remains conscious of the intense heat produced by the electrocoagulation and, unless sufficient intervals are allowed for its adequate dissipation, it will prove exhausting. This is time-consuming and, therefore, useful only in cases of small growths.

After suitable anesthesia, the patient is placed on the operating table in the Sims' or lithotomy position. The Sims' position is best suited for lesions located on the lateral and anterior walls; the lithot-

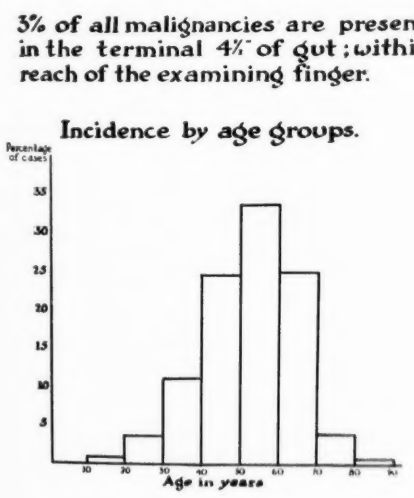

Fig. 1.

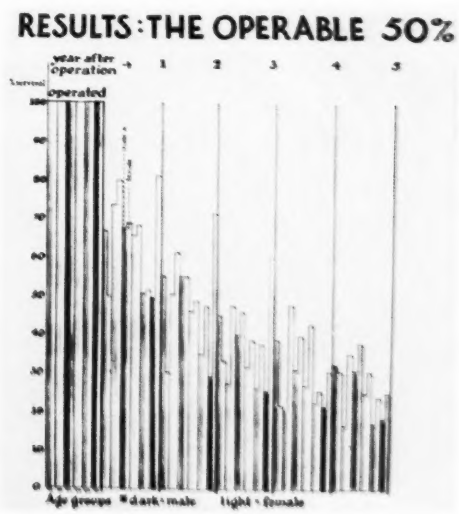

Fig. 2.

Fig. 1. Incidence of carcinoma of the rectum by age groups. (From an analysis of 6,000 cases of carcinoma of the rectum reported in the literature.)

Fig. 2. The probability of survival after recovery from a radical operation.

omy position for lesions on the posterior wall.

Proper exposure of the lesion is essential and this is best secured by the use of a bivalve vaginal speculum which is hinged on one side only and, in addition, has a rack and pinion arrangement which permits a parallel separation of the blades. The rectum is wiped clean. The lumen above the lesion is packed with gauze to avoid soiling the operative field from above. The lesion, if situated low in the rectum, may be brought into view between the sides of the open blades of the speculum. If the tumor is situated beyond the ends of the blades, it may be grasped with a suitable clamp and brought into view. Since the tissues are friable, they should be handled gently, but unless the lesion is kept within the field of vision, incomplete removal may result.

The usual electrode handle is made of hard rubber and is approximately three-eighths of an inch in diameter, large enough to interfere with the proper observation of the tip of the electrode. This is especially true if the electrode tip is in straight line with the handle. Visibility of the operative field may be considerably improved by the use of a thin rigid copper wire, covered with a small rubber tube for insulation, instead of the ordinary electrode handle. The tip is bent at a 60-degree angle and terminates in a point or small loop. With proper observation of the tip of the electrode, one can always see that the electrode is in actual contact with the tumor before closing the circuit and thus avoid sparking to the speculum or normal tissues.

Protruding and polypoid masses, if present, may be removed by grasping with a forceps and severing their attachment by means of the electrode. The rest of the growth is destroyed by successive applications of the electrode and the co-

Fig. 3.

Fig. 4.

Fig. 3. Case P. B. An unusually large annular papillomatous carcinoma of the rectum, in a woman 73 years of age, producing almost complete obstruction.

Fig. 4. Case P. B. Appearance of colon after mass had been destroyed by electrocoagulation. The obstruction was completely relieved without recourse to colostomy.

agulated tissue removed by morcellation. The borders of the growth, which constitute the germinating portion, must be completely destroyed and some of the adjacent normal structures must be sacrificed in order that this may be properly accomplished. Great caution must be exercised to avoid perforation of the gut.

TABLE I.—SYMPTOMS IN ORDER OF FREQUENCY AS FIRST SYMPTOMS

		Percentage
1.	Constipation	33
2.	Pain in rectum	28
3.	Blood in stools	23
4.	Tenesmus	7.5
5.	Discharge from rectum	3
6.	Emaciation	2.5
7.	Dysuria	1
8.	Ribbon-like stools	1

Twelve months is the average duration of symptoms before treatment.

Smoke coming from the charred tissues will constantly obscure the field and can be removed by a suction tube or by the use of a loose sponge held in a ring clamp and plunged like a piston through the speculum. This ventilates the rectum and sponges the field at the same time.[2]

Upon completion of electrocoagulation, the gauze pack above the lesion is removed. Radium is then applied directly to the site of the tumor base using platinum tubes of 1 mm. wall thickness and delivering a dose of from 100 to 125 mg.-hr. per square centimeter of surface. To keep the radium in proper apposition, we have found that the use of a large rubber tube about one inch in diameter, the size of the ordinary garden hose, serves as an excellent applicator. The rubber tube has a gentle curve, just about enough to conform to the curvature of the sacrum. The radium tubes are first arranged on a piece of adhesive tape to cover an area comparable to the size of the tumor site. This is then attached to the outer surface of the rubber tube, corresponding to the location of the lesion. The surface of the tube is then lubricated, introduced into the rectum, and the radium brought in contact with the tumor site. About one inch of tubing is permitted to protrude from the rectum, the rest being cut off. A silk suture is then passed through the wall of the tube and anchored

Fig. 5. Case P. B. Radium tubes applied to the tumor site and maintained in position by a tight gauze packing.

Fig. 6. Flat crater-like excavated growth. Margins are nodular and elevated.

[2] One manufacturer has combined the electrode and suction tube, but this has the disadvantage of being too bulky.

to the skin of the buttock. This prevents the tube from slipping in or out of the rectum. A longitudinal slit is cut in the protruding portion of the tube, and the peroneal tape of a "T" binder is passed through the slit. This offers an additional safeguard against rotation and slipping. We have found this applicator superior to any heretofore employed, as the diameter of the tube is sufficiently large to keep the rectum distended, maintain sufficient drainage, and assure adequate contact between the radium and the site of the lesion. Gauze packing, when utilized to keep radium tubes in place, is useful only for short periods and is almost sure to be displaced after a few hours.

Very little or no reaction is experienced by the patient. The temperature may rise from one-half to one degree. The patient is kept on a liquid diet for a few

Fig. 7.

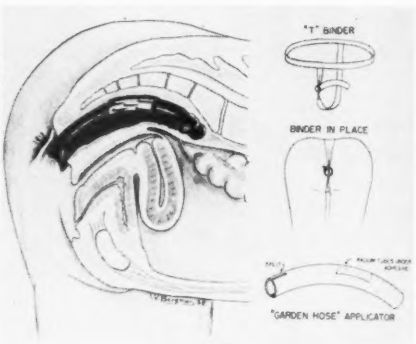

Fig. 8.

Fig. 7. The vaginal speculum makes an excellent operating proctoscope, giving adequate exposure of the lesion. The electrode is in contact with a small papillomatous carcinoma.

Fig. 8. A large rubber tube, of garden-hose size, makes an excellent radium applicator. The curve in the tube conforms to the sacral curvature. The radium tubes are affixed to the rubber applicator with adhesive. A silk suture, anchored to the buttock and a longitudinal slit in the protruding portion of the tube prevent the tube from slipping or rotating. The large lumen permits adequate drainage.

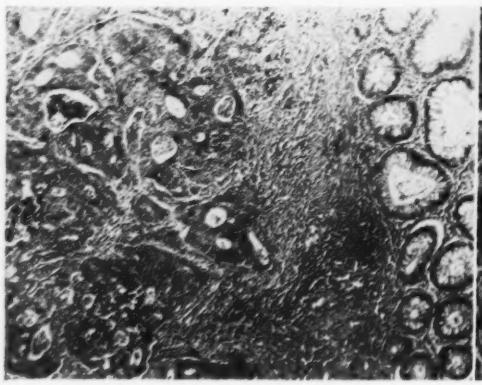

Fig. 9.

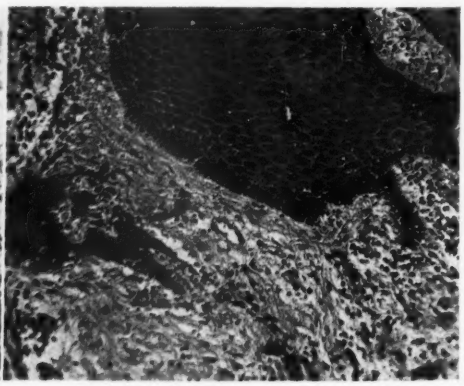

Fig. 10.

Fig. 9. Photomicrograph of an adenocarcinoma of the rectum. Base of mucosa shows crypts lined by histologically normal mucus-bearing epithelium. Submucosa invaded by irregular masses of neoplastic cells in distinct pseudoglandular arrangement.

Fig. 10. Photomicrograph of epidermoid carcinoma of the rectum. The surface is lined by degenerating stratified squamous epithelium. Underlying stroma is invaded by sheets of atypical squamous cells.

days while the treatment is being carried out, and one-half ounce of mineral oil is given morning and evening. Opiates in small doses are useful. About two days is usually required to deliver the average radium dose, after which the tube is removed. The average stay in the hospital is only four or five days.

Results.—The lumen of the colon which may have been partially or almost completely obstructed becomes immediately patent and the patient can have normal bowel movements as soon as the dressings are removed.

The patient commonly complains of pain in the rectum for the next two or three weeks. This pain is the result of direct surgical trauma as well as a proctitis produced by radiation and requires the continued use of sedatives. In our early cases, we delivered a cycle of roentgen therapy to the pelvis immediately after the patient left the hospital. We found that this aggravated the rectal pain. We now wait three weeks for the subsidence of the local reaction before administering roentgen therapy.

The factors employed for roentgen therapy were 200 kv., 6 ma., 50 cm. distance, 0.5 mm. Cu plus 1 mm. Al filters to each of two anterior and two posterior 15 × 15 cm. ports, and a total of 1,600 r to each port. During the past year we have employed supervoltage, using 400 kv., 4 ma., 70 cm. distance, 3 mm. Cu plus 1 mm. Al filters to four ports, for a total of 2,600 r to each port. The percentage depth dose is greater, resulting in a larger quantity of radiation reaching the involved structures. Even in cases in which the initial skin reaction appears the same, the ultimate recovery is better after supervoltage. Even hair follicles are not permanently destroyed. After epilation, we have noticed black hair return where gray hair was previously present.

Kolischer, in 1910, introduced the use of electrocoagulation in inoperable cancer cases. Since then, Strauss, of Chicago, has reported 73 cases treated by electrocoagulation and has qualified his results as "remarkable." Many of his patients have lived eight and ten years. He found that, even in instances in which adjacent glands were involved, the arrest of activity in the primary growth caused a recession of these glands.

In our hands, this method has also proved most gratifying. During the past four years we have treated 26 cases of carcinoma of the rectum by electrocoagulation, radium, and roentgen therapy. There were 16 males and 10 females. The youngest was 49 years of age and the oldest 73

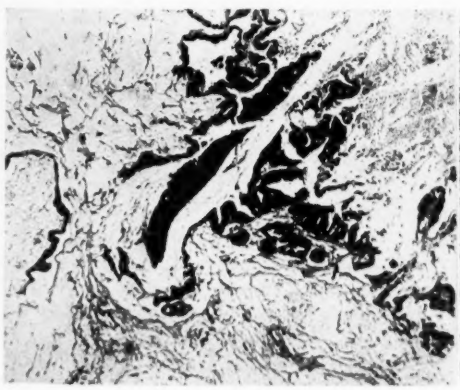

Fig. 11.

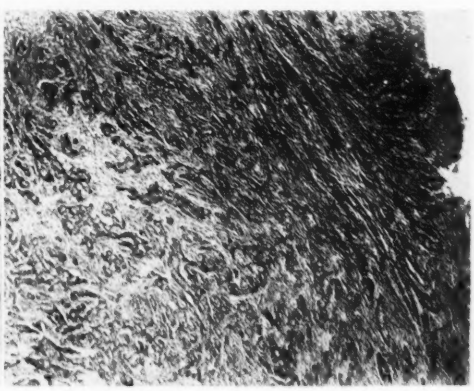

Fig. 12.

Fig. 11. Photomicrograph of colloid carcinoma of the rectum. The mucoid stroma contains columnar neoplastic cells in papillary and pseudoglandular arrangement.

Fig. 12. Photomicrograph showing effects of radiation on cancer. The stroma shows extensive degeneration. Individual cells have undergone lysis. No malignant cells are visible.

TABLE II.—SUMMARY OF CASES TREATED BY ELECTROCOAGULATION AND RADIATION

Date	Case	Age	Sex	Clinical Type	Pathology	Radium mg.-hr.	Died 1st yr.	Died 2nd yr.	Died 3rd yr.	
1-1935	J. C.	73	M	Papillary	Adeno. ca.	1950		D		
3-1935	L. S.	74	M	Flat crater	Adeno. ca.	2000	D			
4-1935	P. C.	63	F	Annular papillary	Adeno. ca.	1800				
5-1936	R. U.	59	M	Papillary	Adeno. ca.	2150		D		
7-1936	A. L.	56	M	Papillary	Gelatinous adeno. ca.	1840				
8-1936	E. P.	67	F	Annular	Adeno. ca.	2400				
8-1936	H. R.	72	M	Papillary	Papillary adeno. ca.	2500		D		
10-1936	M. C.	65	F	Papillary	Adeno. ca.	2300				
3-1937	P. B.	73	F	Annular	Papillary adeno. ca.	2400				
5-1937	I. K.	71	M	Flat crater	Adeno. ca.	1860				
8-1937	M. G.	72	M	Annular flat	Adeno. ca.	2000				Had previous colostomy
8-1937	C. C.	58	M	Flat elevated	Papillary adeno. ca.	1900				
9-1937	H. C.	67	M	Annular	Adeno. ca.	2200				
9-1937	J. B.	71	F	Flat irreg. crater	Adeno. ca.	2000				
10-1937	T. H.	72	M	Elevated flat	Squamous ca.	2400				
10-1937	M. S.	59	M	Flat ulcerative	Adeno. ca.	2400	D			Had colostomy for relief of rectal pain. Died of operation
11-1937	T. O.	72	M	Papillary	Papillary adeno. ca.	2100				
12-1937	P. C.	51	F	Annular	Adeno. ca.	2700				
2-1938	K. G.	56	F	Papillomatous	Adeno. ca.	1900				
4-1938	V. T.	73	M	Annular	Colloid	1500				
5-1938	E. C.	68	F	Papillary	Adeno. ca.	1750				
5-1938	J. N.	71	M	Papillary	Colloid	1900				
6-1938	P. R.	70	M	Annular	Adeno. ca.	1840				
7-1938	V. A.	49	F	Flat crater	Adeno. ca.	1800				
8-1938	P. S.	50	M	Flat indurated	Adeno. ca.	1056				
9-1938	P. B.	65	F	Papilloma	Adeno. ca.	2000				

Recapitulation—26 Cases Treated

Year	Male	Female	Died	Living
1935	2	1	2 M	1 of 3 after 3 years
1936	3	2	2 M	3 of 5 after 2 years
1937	7	3	1 M	9 of 10 after 1 year
1938	4	4	0	All

years. The average age was 65 years. Males averaged 66.6 years, while females averaged 62.8 years. One patient was under 50 years of age, seven between 50 and 59 years, six between 60 and 69 years, and 12 over 70 years. One patient had a previous colostomy before coming for treatment. Another had a colostomy three months after treatment, for the relief of rectal pain. This was performed at another institution and, unfortunately, the patient did not survive the operation. Colostomy was avoided in every other case, even in cases in which obstruction was present at the time of treatment. One patient had an unusually large annular papillomatous mass completely blocking the lumen (Fig. 3). The entire mass was removed by electrocoagulation with complete relief. We have had no operative mortality.

Secondary symptoms, due to toxic absorption from the infected bowel, soon disappear. The patient gains weight and shows an improved blood picture. Of the males treated, two died within the first year, and three within the second year. All the females are still living, one over three and one-half years.

Comment.—It is important to emphasize that radical surgery has an important place in the treatment of carcinoma of the rectum. Unfortunately, many cases are too advanced for successful radical surgery. In such cases, in which the growth is accessible through the anus, the tumor

TABLE III.—AGE DISTRIBUTION BY DECADES

	40	50	60	70	Total
Male		5	1	10	16
Female	1	2	5	2	10
Total	1	7	6	12	26

can be destroyed by electrocoagulation. This procedure *per se* establishes a patent colonic tube and avoids the necessity for a colostomy. The fact that this can be accomplished with a minimum of risk makes it applicable to all patients, regardless of their local or general condition. The destruction of the primary growth by electrocoagulation, followed by the application of radiation, has a definite retarding influence on adjacent metastases, thereby contributing to the immediate relief and ultimate prolongation of the life of the patient.

It must be remembered that the graphs illustrating the percentages of survivals in the operable group are only of those who survived the operation, whereas in the group reported here treated by electrocoagulation and radiation, the survival graphs apply to the total number of cases treated, as no operative mortality was experienced.

We realize that the period of observation covered by this report is too short to be conclusive, but, nevertheless, the results are impressive, in view of the fact that all of the cases dealt with belong to the inoperable group. It is now reasonable to assume, in view of these results, that the mere establishment of a colostomy in cases of inoperable carcinoma of the rectum, without any treatment being directed to the primary lesion, must be considered inadequate.

Summary.—The subject of carcinoma of the rectum is briefly reviewed, especially as it applies to the non-operable group. The method of treatment of the rectal tumor by electrocoagulation and radiation is described in detail. A series of 26 cases of inoperable carcinoma of the rectum treated by this method is reported. A new rubber "garden-hose" rectal applicator for radium is described.

BIBLIOGRAPHY

1. BETTMAN, R. B.: Use of Surgical Diathermy in Relief of Cases of Inoperable Carcinoma. Arch. Phys. Therapy, **15,** 80–82, February, 1934.
2. BINKLEY, GEORGE E.: Treatment of Inoperable Rectal Cancer. S. Clin. North America, **16,** 871–884, June, 1936.
3. BOWERS, W. F.: The Electrocoagulation Treatment for Inoperable Carcinoma of the Rectum. Nebraska Med. Jour., **23,** 41–44, February, 1938.
4. BOWING, HARRY, H., and FRICKE, ROBERT E.: Primary Rectal Carcinoma under Radiation Treatment: A Statistical Review of 500 Cases. Am. Jour. Roentgenol. and Rad. Ther., **32,** 635–645, November, 1935.
5. DALAND, ERNEST M., WELCH, CLAUDE E., and NATHONSON, IRA: One Hundred Untreated Cancers of the Rectum. New England Jour. Med., **214,** 451–458, March 5, 1936.
6. EWING, JAMES: Neoplastic Diseases. W. B. Saunders Co., Philadelphia, 1928.
7. JOHNSON, J. A.: Electrocoagulation of Carcinoma of Rectum and Sigmoid. Minnesota Med., **18,** 487–490, July, 1935.
8. Ministry of Health, No. 46. Report on Carcinoma of the Rectum. London, England, 1927.
9. PETTIT, ROSWELL T., and EDGCOMB, J. H.: Critical Analysis of Methods of Treatment of Rectal Carcinoma, Particularly Electrocoagulation. Am. Jour. Surg., **34,** 57–64, October, 1936.
10. RANKIN, FRED W.: What can We Expect from Radical Surgery for Rectal and Rectosigmoidal Cancer? Southern Surgeon, **5,** 192–199, June, 1936.
11. STRAUSS, A.: Surgical Diathermy of Carcinoma of the Rectum and its Clinical End-results. Arch. Phys. Therapy, **14,** 212–214, April, 1933.
12. STRAUSS, A. A., STRAUSS, S. F., CRAWFORD, R. A., and STRAUSS, H. A.: Surgical Diathermy of Carcinoma of Rectum: Its Clinical End-results. Jour. Am. Med. Assn., **104,** 1480–1484, April 27, 1935.
13. STRAUSS, A. A., STRAUSS, S. F., and STRAUSS, H. A.: A New Method and End-results in the Treatment of Carcinoma of the Stomach and Rectum by Surgical Diathermy (Electric Coagulation). South. Surgeon, **5,** 348–359, October, 1936.
14. THORLAKSON, P. H. T., and HAY, A. W. S.: Carcinoma of the Rectum and Rectosigmoid (Report of 89 Cases with Special Reference to Electrocoagulation in Selected Cases). Canadian Med. Assn. Jour., **38,** 107–119, February, 1938.
15. YEOMANS, FRANK C.: Proctology: A Treatise on the Malformations, Injuries, and Diseases of the Rectum, Anus, and Pelvic Colon, second edition, Appleton-Century, New York City, 1936.

SHELLAC BEZOARS[1]

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From the Inlow Clinic

SHELLAC bezoars are rare. In a thorough search of the literature I have found only ten instances recorded, two by Norwegians and eight by Germans. I wish to add an eleventh case, which I believe to be the first of this type reported in the English literature, and the first to have been demonstrated roentgenographically.

Case Report.—A worker in a mirror factory, aged 33 years, was referred to me on Dec 4, 1935, by Dr. W. C. McFadden. In childhood the patient had been told that his heart was on the right side. For the past two years, he had complained of burning and pain in the left upper abdomen, with such relationship to meals as to be suggestive of peptic ulcer. Persistent treatment with alkalies, however, had failed to relieve his distress.

Physical examination revealed only that the cardiac dullness and apex beat were to the right of the sternum.

Upon fluoroscopic investigation, the right leaf of the diaphragm was found to be in normal position, with excellent excursion. The left leaf was about five inches higher than usual, with its margin sharply defined, and its excursion limited to 0.25 inch. The heart was displaced to the right with the apex beneath the sternum, but the aortic knob was in its usual position. The lungs were normal. The trachea was deviated to the right. There was an oval, dense mass below the left leaf of the diaphragm, plainly visible without contrast medium. This mass floated in the barium suspension, the upper portion projecting into the gastric air bubble. The position of the stomach was anomalous (Fig. 1). The esophagus entered the stomach at the normal level. The fundus was the most dependent part of the stomach, the pars media being under the left diaphragmatic leaf, with the pars pylorica and the duodenum descending anteriorly and far to the left side, almost vertically. No peristaltic waves were visible. There was a deep niche on the lesser curvature of the pyloric antrum. Six hours after the meal (Fig. 2) there was a small amount of barium retained in the stomach, outlining the mass distinctly. The colon was normal, with the splenic flexure extending high under the left leaf of the diaphragm.

The diagnoses made in this case were bezoar, gastric ulcer, eventration of the diaphragm with malposition of the stomach and heart (probably congenital).

Questioning of the patient did not reveal any history of ingestion of hair or persimmons; consequently, we were uncertain as to the type and origin of the bezoar.

On Dec. 16, 1935, the mass was removed by gastrotomy. The patient had a mild post-operative bronchitis, with an otherwise uneventful convalescence. He left the hospital on the twelfth day, apparently cured.

Re-examination on April 14, 1939, showed normal motility, and no evidence of bezoar or niche. Otherwise, the findings were unchanged.

Description of the Bezoar.—On inspection, the bezoar was found to be black, roughly oval in the long and circular in the transverse diameter, with tiny smooth nodules and considerable fissuring on its surface. It was hard on palpation. Following its removal it barely floated in tap water. During fixation in formalin solution, it became smaller, having a volume of 125 c.c. and a weight of 129.5 gm., with a specific gravity of 1.036. It was 11 cm. long and 5.3 cm. wide.

A roentgenogram of the bezoar (Fig. 3)

[1] Accepted for publication in August, 1939.

showed the fissuring of its surface, similar to check marks on varnished furniture. Otherwise the density was uniform.

On cutting into the mass, it proved to be brittle, the cut surface being light brown and showing occasional inclusions of food particles. Since it obviously was neither a trichobezoar nor a phytobezoar, but had the characteristics of varnish, it was sent to a chemical laboratory for analysis. They reported, "We have examined the bezoar body for shellac, with positive results." No quantitative analysis was done.

Origin of the Bezoar.—After discovering the nature of the bezoar, we could surmise its probable origin. We supplemented our history by questioning the patient's employer and fellow-workers. We found that in making mirrors, a coat of shellac is applied to the back of each mirror after the silvering process. This shellac is a solution of two pounds of scale shellac to the gallon of specially denatured alcohol (89.5 per cent ethyl alcohol denatured with 10 per cent of methyl alcohol and 0.5 per cent of benzine). During the period of national prohibition, some of the employees, including our patient, had used this shellac solution as an intoxicant. The technic used was to add shellac solution to a glass of dry beer while stirring with a rod, in order to precipitate and remove most of the shellac. The remaining liquid constituted an unpleasant but intoxicating beverage.

Calculating from the formula of the shellac solution and the weight of the bezoar, it is apparent that a patient would have to drink over a pint of undiluted mixture and retain all of the shellac in his stomach, in order to form a bezoar of this size. Since most of the shellac was precipitated and removed before drinking, our patient must have imbibed a much larger quantity.

It is probable that shellac solution (disregarding the toxic effect of the methyl alcohol) can be and has been used with impunity in the manner described, since the small amount of shellac not removed before drinking and subsequently precipitated, would be eliminated promptly by the normal stomach. Our patient was unfortunate in that his stomach was so situated that it would retain indigestible material and allow a bezoar to form by accretion.

Fig. 1. Oblique view of stomach. (*A*) Right leaf of diaphragm; (*B*) left leaf of diaphragm; (*C*) bezoar; (*D*) gastric ulcer niche; (*E*) esophageal opening; (*F*) fundus; (*G*) pylorus.

Review of Literature.—1. The first case of shellac bezoar was reported, in 1865, by Tidemand (8), of Norway. His patient was a 28-year-old prisoner, a drunkard. During his incarceration, he ornamented and varnished toys for five months, during which period he complained of pain in the epigastrium, nausea, heart burn, loss of appetite, and a mass in the abdomen. Several days after becoming bedfast because of weakness, dizziness, and vomiting, he had sudden severe pain in the abdomen, and died twelve days later. At necropsy there was a generalized peritonitis from perforation of a large gastric ulcer. The stomach was filled with a hard brown mass weighing 1265 gm., which on

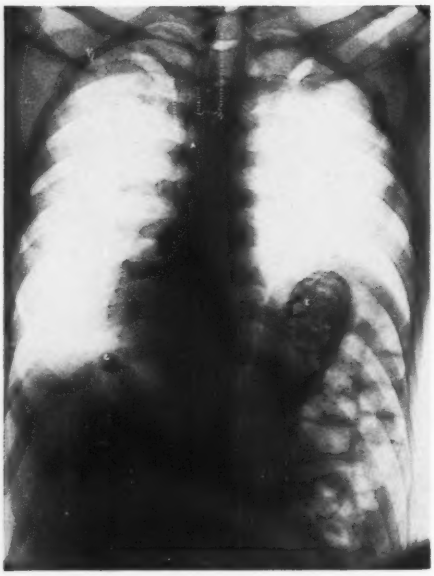

Fig. 2. Anteroposterior view taken six hours after a barium meal. (*A*) Trachea displaced to right side; (*B*) right margin of heart; (*C*) right leaf of diaphragm; (*D*) left leaf of diaphragm; (*E*) bezoar outlined by barium; (*F*) splenic flexure of colon.

chemical examination was found to be shellac. Calculation revealed that the patient must have drunk at least 7.25 quarts of shellac varnish, or about three tablespoonfuls daily while working.

2. In 1880, Langenbuch (5) recorded the instance of a young man with ileus, which could not be relieved by medical treatment. The age, occupation, or further details of the history were not given. Upon operation, a 4 × 10 cm. concretion was removed from the jejunum. Following this, the patient passed stools but continued to vomit, and finally died. There was a much larger similar concretion in the pyloric part of the stomach (weight and size not stated). At the time of his report, Langenbuch was uncertain concerning the nature of these concretions However, Manasse, in a footnote to his article, states that Langenbuch later analyzed them, and found them to be shellac.

3. Friedländer (1 and 2), in 1881, reported the case of a middle-aged tablemaker, a drunkard accustomed to drinking alcohol in any form. He died from obstruction of the lower ileum by a shellac concrement. Other concrements having a combined weight of 960 gm. were found in the stomach. Friedländer noted that there was polyposis and pigmentation of the gastric mucosa.

4. Grauer (3) cited a case, in 1892, and mentioned the above three cases. His patient, a man, was a 60-year-old painter (an inmate of the poorhouse), who had suffered from attacks of pain in the upper abdomen for several years. Upon medical treatment, he always had improved enough to resume his occupation. He was sent to the hospital because of a sudden severe pain in the epigastrium which could not be relieved by narcotics. He had dyspnea and a fast thready pulse. His abdomen was tympanitic and quite tender. There was neither hiccough nor vomiting. He died two days later from a generalized peritonitis. The stomach was fixed in a mass of adhesions; there was a small perforation of the gastric wall through the center of a large scar, and there were several other scars in the mucous membrane. Inside the stomach, there was a hard mass which weighed 370 gm. and was composed of shellac. The past history of this patient, combined with the necropsy findings, indicated that he had been drinking varnish for years, and that the presence of the bezoar had produced several gastric ulcers.

5. In 1895, Manasse (6) saw a 44-year-old alcoholic who complained of pain in the abdomen and of vomiting. The patient died of pulmonary and peritoneal tuberculosis. There was a gastric ulcer near the pylorus and a cylindric, green-black, laminated mass in the stomach. This concrement was 10 × 5 × 4 cm. in size, weighed 75 gm., and, chemically, was shellac.

6. Vonnegut (9), in 1897, saw a 54-year-old wood-stucco worker who had had gastric symptoms since he began drinking shellac 18 years previously. He always had improved on diet and rest in bed. He, himself, had felt a hard mass under the left costal margin. Since he

improved in spite of a provisional diagnosis of carcinoma, an exploratory operation was performed. Two concrements having a combined weight of 670 gm. were removed by gastrotomy. The patient recovered. Quantitative analysis of the bezoars showed: resin (shellac), 88.17 per cent; nitrogenous material, 2.81 per cent; starch, 3.28 per cent; minerals, 1.7 per cent, and water, 4.04 per cent.

7. K. Schultze (7), in 1906, reported the instance of a patient, 46 years of age, who had complained of cramp-like pain in the abdomen for four months. On examination a hard tender mass was found in the upper abdomen which could be pushed about easily. Schultze's preoperative diagnosis was carcinoma of the pylorus. An exploratory incision was made and two concretions were removed by gastrotomy. These masses (weight not stated) were composed of shellac. The patient's recovery was uneventful. Upon further questioning after operation, he admitted that he had been drinking shellac solution for 16 years.

8. Hallas (4) reported two cases, in 1914, reviewed part of the literature, and discussed his experimental production of shellac bezoars in animals. His first patient was a 72-year-old furniture worker, a drunkard who had been hospitalized several times for delirium tremens and chronic nephritis. He died of intestinal obstruction due to a piece of concrement in the ileum. There was a much larger similar concrement filling the stomach and first portion of the duodenum. These two masses weighed 1745 gm., and consisted of shellac. There was an adenomatous polyp of the gastric lesser curvature.

9. Hallas' second patient was a man, 29 years of age, who had had delirium tremens ten years previously. He complained of sudden severe pain in the abdomen. Death was due to peritonitis from perforation of a gastric ulcer on the lesser curvature. There were three shellac bezoars present, a large one occupying most of the stomach, with small ones in the pyloric antrum and duodenum. Their combined weight was 2000 gm. Hallas' two cases had the largest shellac bezoars which have been recorded.

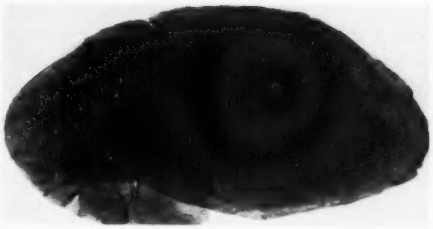

Fig. 3. Roentgenogram of bezoar showing marked fissuring of its surface.

10. The last case was reported, in 1918, by Wendt (10). This patient, 48 years of age, was admitted to the hospital complaining of anorexia, loss of weight, pleurisy, and abdominal pain. He was disorientated, talked irrationally, and had hallucinations. On physical examination, râles were found over both upper lobes. In the belly, which was rigid, there was a hard tender tumor which moved with respiration. The patient was too unruly to examine roentgenoscopically. Surgical intervention was not considered because of the poor general condition of the patient. A diagnosis of carcinoma of the stomach, with pulmonary tuberculosis and inanition psychosis, was made. The patient died in about a month, the abdominal findings having remained unchanged. Necropsy revealed a bilateral fibrous pulmonary tuberculosis; tuberculous pleuritis; caseous mesenteric glands; and a concretion in the stomach with an adjacent large gastric ulcer. The bezoar was greenish-brown and hard, forming a true cast of the stomach. It was 15 × 6.5 × 7 cm. in size, floated in water, and weighed 380 gm. Chemical analysis showed that it consisted almost entirely of shellac.

DISCUSSION

Nature and Use of Shellac.—Lac is a resinous substance secreted by the scale insect (*Coccus lacca*) which lives on the twigs of various trees, especially certain species of the genus *Ficus*. The insects

are cultivated extensively in northern India. Lac, in its natural state, incrusts the bodies of the dead insects and the small twigs upon which they had fed. These twigs, when broken off, form stick-lac. After removal of lac dye, and having been reduced to a thin crust, the lac is termed *shell-lac*, or *shellac*. It forms an important ingredient of varnishes, lacquers, and sealing wax.

Shellac is an organic compound, soluble in alcohol, insoluble in water, hydrochloric acid, and alkaline solutions It burns with a crackling flame, leaving practically no ash.

Alcoholic solutions of shellac are used in trades of all sorts, but especially in the furniture industry, in which enormous quantities are required.

Terminology.—In reviewing the literature, one is surprised at the number of terms used in describing shellac retained in the stomach. The Norwegians have used the expressions clump, clod, and concrement, while the Germans have preferred stone, concrement, and concretion.

In English terminology, these nouns refer ordinarily to inorganic collections of material. Organic masses in the upper intestinal tract are classified as bezoars (phytobezoar, trichobezoar, tricho-phytobezoar) of one type or another depending upon the material of which they are composed. For this reason, the term "bezoar" seems to be the most appropriate to use in the case of shellac.

Etiology of Shellac Bezoar.—It is obvious that in all cases reported, the patients have drunk shellac solution in some form.

A craving for alcohol is probably one of the most important factors in the cause of shellac bezoar. In most of the cases reported, definite reference is made to the fact that the patient was a drunkard. Hallas' two patients had had delirium tremens. Wendt's patient had a psychosis which may have been alcoholic in origin. The mere fact that such an unpalatable beverage as alcoholic shellac solution has been used for intoxicating purposes, indicates this abnormal appetite.

Occupation plays a rôle on etiology. All the cases reported worked at a trade in which alcoholic solution of shellac was available and used in considerable amounts.

Circumstances in conjunction with the factors noted above seem also to have had some bearing on etiology. One patient was in prison, another in a poorhouse, and it is probable that poverty and inability to pay for alcoholic beverages was operative in some cases. In our case, the period of national prohibition made it difficult to get alcohol in any form.

Shellac bezoars have been found only in *males*. This may be explained by the fact that drunkards are much less common in the female sex and that they seldom work in the trades in which shellac is used. However, the latter statement is merely conjecture.

Age is a minor factor, as cases have been recorded in patients ranging in age from 28 to 72 years. It seems that the only requisite is time enough to imbibe shellac in quantities sufficient to form a bezoar.

It is strange that all the cases of shellac bezoar have been reported by Germans and Norwegians. The only plausible explanation that presents itself is that these countries must have far more industries in which shellac is used. It is improbable that *race* is of any further significance.

Abnormality of position of the stomach was noted in only one case. In no case is there any mention made of pyloric obstruction. Hence we must conclude that shellac bezoars may form in apparently normal stomachs, although anomalous position or pyloric stenosis may be considered predisposing causes.

Precipitation of shellac in the stomach is readily explainable. First, the alcohol which keeps it in solution is absorbed by the gastric mucosa. Dilution by mixture with fluid in the stomach further reduces the alcoholic percentage and hastens precipitation. The presence of hydrochloric acid, in which shellac is insoluble, in combination with the other factors, makes precipitation inevitable. Granting almost

complete precipitation of shellac before it can leave the stomach, one would expect it to pass through readily, unless a quantity too large to clear the pylorus was imbibed at one time and immediately molded together by the gastric peristalsis.

Experimental Production of Shellac Bezoars.—The only experimental work which has been done in producing shellac bezoars was reported by Hallas (4). He performed a series of 30 experiments, using rats as experimental animals and commercial polish as the source of shellac.

He found that the addition of a small amount of water precipitated about 50 per cent of the shellac as a brown substance, which would collect together into a large plastic mass when shaken, later becoming quite hard when left in the fluid medium. The addition of hydrochloric acid or sodium chloride to the water did not seem to influence the result of the precipitation.

His procedure was to anesthetize a rat with ether, then to pass a small rubber catheter down the esophagus into the stomach. Using a graduated syringe, he injected doses of shellac varying from 0.5 to 4 gm., with a total dose of from 1 to 22.5 gm. given in from one to seven injections, at intervals of from 2 to 81 days. The rats withstood the procedure quite well, four surviving over 100 days, four over 200 days, and three over 300 days. "It was quite simple by this method to bring about the formation of shellac concrements in the stomachs of rats."

Hallas found two types of bezoars. In the first few days after injection, the shellac was *always* a loosely formed porous mass covering the stomach wall. The second type was a massive rounded hard concrement. If more than one were present, they had faceted articulating surfaces. The number varied from one to seven, two being the most frequent. He never found one in the duodenum, and only once did he find a small one in the lower intestine.

He concluded that the origin and fate of shellac bezoars depended upon the amount of material injected and upon the time elapsing after injection. If small amounts were injected (0.5 to 1 gm.), a concrement was formed which disappeared after a few days. If from 1.5 to 3 gm. injections were used, the stomach later could be empty, but the period after injection was much longer before this occurred.

He also observed that the longer the animal lived after injection, the greater was the difference between the weight of the bezoar and the amount of the material injected. In the first few days, this relation was (amount injected) 2 to (bezoar) 1. Later the relation might be 7 to 1. He thought that the mechanical manipulation by the stomach wall accounted for the reduction in size which he noted. He proved that there was no fixed relation between the number of bezoars found and the number of injections of shellac solution, because he was able to produce single bezoars by repeated injections, and multiple bezoars by a single injection.

On macroscopic examination, he found no pathologic changes in the gastric mucosa, such as ulceration or tumor formation. Sometimes the stomachs were dilated, sometimes firmly contracted upon the bezoar.

Microscopic examination revealed no acute or chronic alterations in the gastric mucosa, such as inflammatory changes, hyperkeratosis, eosinophilia, or plasma cells, which could be attributed to the presence of a bezoar. Even in rats which had lived over ten months with large concrements in the stomach, there was no hypertrophy of the muscular layers.

In one case there was a bezoar firmly incarcerated in the pyloric end of the stomach which might have caused obstruction. In the other cases, the writer could not state definitely the cause of death. Peritonitis and intestinal obstruction, which killed his two patients, were not observed in any of the rat experiments.

Pathology.—In contrast to the absence of pathologic changes in the abdomen of rats with bezoars, the cases reported in

the human have shown a variety of abnormalities. In the three cases which were cured by operation, there were no pathologic findings reported except a gastric ulcer in our patient. In the other eight cases, necropsy revealed five gastric ulcers, three of which had perforated, with a generalized peritonitis. Adhesions immobilizing the stomach were present once, pigmentation of the gastric mucosa once, and polyps twice. Three patients died of ileus, and the remaining two of tuberculosis.

TABLE I.—SHELLAC BEZOARS

No. Cases	Date	Author and Country	Method of Diagnosis	Complaint	Result	No. Bezoars Found	Age	Weight in gm.
1	1865	Tidemand Norway	Autopsy	Peritonitis from perforated gastric ulcer	Death	1	28	1325
2	1880	Langenbuch Germany	Surgery and autopsy	Ileus	Death	2	Young	Large
3	1881	Friedländer Germany	Autopsy	Ileus	Death	Several	Middle aged	960
4	1892	Grauer Norway	Autopsy	Peritonitis from perforated gastric ulcer	Death	1	60	370
5	1895	Manasse Germany	Autopsy	Lung and peritoneal tuberculosis	Death	1	44	75
6	1897	Vonnegut Germany	Surgery	Stomach distress, mass in abdomen	Cured	2	54	670
7	1906	Schultze Germany	Surgery	Cramp-like pain and mass in abdomen	Cured	2	46	Palpable
8	1914	Hallas Germany	Autopsy	Ileus	Death	2	72	1,745
9	1914	Hallas Germany	Autopsy	Peritonitis from perforated gastric ulcer	Death	3	29	2,000
10	1918	Wendt Germany	Autopsy	Abdominal pain and mass; pulmonary tuberculosis; inanition psychosis	Death	1	48	380
11	1939	Inlow U. S. A.	X-ray examination	Ulcer history	Cured	1	33	129.5

In the three cases of ileus, shellac bezoar was definitely the cause of the obstruction.

The incidence of gastric ulcer (6 in 11), adhesions (1 in 11), pigmentation (1 in 11), and polyps (2 in 11) is such that the presence of shellac bezoar must be considered the probable cause of these pathologic changes. This conclusion is directly opposed to the experimental findings of Hallas.

Symptomatology.—Pain in the abdomen was the only constant symptom in the cases reported. However, an analysis of the complaints allows one to classify them into four groups.

One group complained of pain in the abdomen, relieved to some extent by rest in bed and medical treatment. In view of their pathologic findings, these patients were probably having distress due to gastric ulcer. Whether this is true or not, one is not able to tell from the case reports. In our case, the history was compatible with a diagnosis of peptic ulcer.

Others had a palpable mass in the upper abdomen, in addition to this complaint of pain. Probable carcinoma of the stomach was the diagnosis in all of these cases.

Three patients complained of nausea, vomiting, and distention, and were apparently clear-cut cases of intestinal obstruction of unknown origin.

The history of sudden severe pain in the abdomen, with rapidly developing evidences of generalized peritonitis, was present in three cases, all of which were typical of perforated peptic ulcer.

It is difficult in such a small series of cases to determine whether or not the size, number, or shape of the bezoars had any definite relation to the symptom-complex except in the cases of intestinal obstruction. Here the bezoars were of such

a size and shape as to pass through the pylorus or duodenum, later becoming incarcerated in the jejunum or ileum.

Diagnosis.—An accurate history is of prime importance in making a diagnosis of bezoar. However, in cases of shellac bezoar, as may be noted in the case reports, the correct history has usually been obtained after the diagnosis has been made by chemical examination of the specimen. Only when confronted by such evidence, have the patients admitted their unusual habit of drinking shellac solution. Consequently, it is probable that from the history alone, one would consider the possibility of peptic ulcer as the cause of the distress, which, after all, may be the true explanation.

Physical findings in the cases without obstruction or peritonitis have been tenderness in the upper abdomen, and, in a few cases, a palpable mass. A hard mass which can be displaced into various parts of the upper abdomen, or which disappears beneath the ribs on the left side, should suggest the presence of a bezoar.

The roentgenographic diagnosis of bezoar has been made numerous times. A dense mass in the left upper abdomen, producing a movable filling defect in the gastric contour, and many times projecting into the air bubble, is almost pathognomonic of bezoar. However, so far as I can determine, there is nothing about the size, shape, position, or density of the bezoar on roentgenograms that would enable one to say whether it is composed of hair, persimmon skins, or shellac.

In intestinal obstruction, it is routine practice to take a plain roentgenogram of the abdomen to confirm the diagnosis and to attempt to locate the point of obstruction. The same thing is true in cases of perforated peptic ulcer with peritonitis, in which demonstration of gas under the diaphragm confirms the diagnosis. In view of these facts, it is possible that some one may demonstrate a shellac bezoar because of its density, even in these emergencies.

On surgical exploration, a hard mass which can be easily moved about inside the stomach and which has no apparent attachment to the gastric wall, is practically always a bezoar.

Upon removal, one should be able to recognize a shellac bezoar by its black external surface, its extreme hardness, its laminated and check-marked contours, its varnish-colored cross-section, and its lack of visible hair fibers.

Chemical analysis for shellac is the final step in making a diagnosis of shellac bezoar, and the only one incontestable.

Treatment.—Gastrotomy with removal of the bezoar, followed by a restricted diet as in other gastric operations, is the only logical method of treatment.

CONCLUSIONS

Shellac bezoars are medical curiosities, being much less common than trichobezoars and phytobezoars. In this small series of cases, the pre-operative diagnosis of bezoar has been made just once by roentgenography. Apparently the diagnosis "shellac bezoar" has been made only by chemical examination of the specimen. However, such a diagnosis is possible, if radiologists will recall this conclusion: Shellac bezoars have been found only in male drunkards who had access to alcoholic shellac solution, and who gave no history of ingestion of indigestible substances.

BIBLIOGRAPHY

(1) FRIEDLÄNDER, C.: Schellacksteine als Ursache von Ileus. Berl. klin. Wchnschr., **18,** 10, 11, 1881.

(2) Idem: Schellacksteine als Ursache von Ileus. Schmidt's Jahrbücher, **189,** 242, 243, Leipzig, 1881.

(3) GRAUER, C.: Om Shellakkonkrementer i Ventriklen og Tarmkanalen. Ugesk. f. læger, **26,** 359–362, Oct. 14, 1892.

(4) HALLAS, E. A.: Ueber Schellackconcremente im Magen und Duodenum. Berl. klin. Wchnschr., **51,** 440–444, 1914.

(5) LANGENBUCH: Magen- und Darmkonkretionen. Zentralbl. f. Chir., **7,** Feb. 14, 1880.

(6) MANASSE, P.: Ueber einen Magenstein. Berl. klin. Wchnschr., **32,** 723, 724, Aug. 19, 1895.

(7) SCHULTZE, K.: Ueber einen Fall von Magensteinen. Deutsche med. Wchnschr., **32,** 1885, 1886, Nov. 15, 1906.

(8) TIDEMAND, N.: En Shellakklump i Ventrikulus. Norsk. mag. f. lægevidensk, **2,** 19, 1865.

(9) VONNEGUT: Ein Fall von Schellacksteinen im menschlichen Magen. Deutsche med. Wchnschr., **23,** 418, 419, 1897.

(10) WENDT, W.: Ueber einen Fall von Schellackstein im Magen. Mitt. a. d. Grenzgeb. d. Med. u. Chir., **30,** 608–614, Jena, 1918.

SERIAL PLANEOGRAPHY (SERIOSCOPY) AND SERIAL PLANIGRAPHY

A CRITICAL ANALYSIS[1]

By JULIUS KAUFMAN, M.D., *and* HARRY KOSTER, M.D., *Brooklyn, New York*

From the Crown Heights Hospital

INTRODUCTION

MANY methods for securing an x-ray film of a designated body section have been published under various names (1, 2). Those most frequently encountered in the literature are: (1) planigraph (Andrews and Ziedses des Plantes); (2) stratigraph (Vallebona); (3) tomograph (Grossman, Chaoul, and Twining); (4) x-ray focusing machine (Kieffer), and (5) laminagraph (Kieffer and Moore). In all of these methods various motions are imparted to the tube, plate, or patient, so that the designated plane (thin body section) is in focus, and is sharply defined on the x-ray plate, the other planes being eliminated from the picture by blurring.

In August, 1936, we introduced an original method which we termed planeography (3, 4, 5). By planeography we were able to accomplish the following:

(1) Roentgenographic films (planeograms) of all the object-planes could be demonstrated.

(2) The depth of the object-planes so demonstrated could be determined by reference to a specially constructed curve, the "standard depth curve."

(3) Localization and mensuration were possible.

(4) It was shown that the planeograms did not represent the object-planes themselves but were only enlarged similar films of such planes, showing varying degrees of enlargement and displacement.

(*a*) By correcting the enlargement of the planeogram, the object-plane could be reconstructed.

(*b*) By correcting the displacement and enlargement of the planeogram, the object itself could be reconstructed.

The delineation of planeograms was accomplished by superimposing two or more standard roentgenograms. Successive planeograms were demonstrated by sliding the roentgenograms one upon the other.

The term, "planeography," was coined by us to differentiate this method from planigraphy, stratigraphy, etc. Regarding this term, Jean Kieffer in a personal communication to us wrote as follows: "I think your differentiation of names is a very good one. Although the basic mathematics are similar to planigraphy, the procedures and results are different."

In September, 1937, Paul Cottenot (6) presented a paper before the Fifth International Congress of Radiology, termed, "Thoracic Serioscopy." The method "consists in taking . . . four stereoscopic roentgenograms of the thorax. The four films are examined while superimposed one over the other in the same negative viewing box. By causing them to slide synchronously one over the other, the different thoracic planes, superimposed from the front backward, are successively brought into evidence, and at the same time one reads on a dial, graduated in centimeters, the depth of each of the planes examined."

The basic principles employed in serioscopy by Dr. Cottenot are the same as those elaborated by us under the term "planeography." Apparently Dr. Cottenot rediscovered planeography independently, terming the method "serioscopy."

Dr. Cottenot employs "two pairs of stereo-roentgenograms, . . . with the axes of shift of the tube perpendicular to one another." This alone would not be sufficient. The axes of the tube shifts must not only be perpendicular to each other, as Dr. Cottenot states, but they must at the same time bisect each other. Under such cir-

[1] Submitted for publication in January, 1939.

cumstances, serioscopy is mathematically sound.

Dr. Cottenot states that by the method employed in serioscopy, "we can explore successively an infinity of thoracic planes, superimposed from the front backward." Also, he states, "it automatically gives in centimeters the distance which separates the lesion from the thoracic walls." We seriously doubt that the serioscopic measurement of depth in centimeters is of much practical value. We hope to substantiate this statement by a critical analysis of serial planeography (serioscopy).

CRITICAL ANALYSIS

In Figure 1, A.1, A.2, A.3, and A.4 represent roentgenograms taken of object-plane, *A*, in space, with target positions, 1, 2, 3, and 4. The roentgenograms have been superimposed in the serioscope, at *F*. By motions imparted by the serioscope, A.1, A.2, A.3, and A.4 are made to coincide, so that they yield planeographic shadow, *P.A*. Planeogram *P.A*. is similar to object-plane, *A*, but it is enlarged, and displaced from its true position, *V.A*. (vertical projection of *A*).

Figure 2 shows a vertical cylinder, *A* . . . *B*, placed above film positions, *F*, and exposed, according to Dr. Cottenot's recommendation, in tube positions, 1, 2, 3, and 4. When the roentgenograms, so taken, are placed in the serioscope (Fig. 3), and the planeograms of *A* and *B* studied, the planeograms will be represented by Figures *P.A*. and *P.B*. The serioscopic images *P.A*. and *P.B*. are not only disproportionately larger than their homologous object-planes, *A* and *B*, but they show variable displacements. If one examines successively, the planeograms from *P.B*. to *P.A*. in the serioscope, one gets the impression that the object viewed is a truncated cone the central axis of which is oblique to the plane of the plate, rather than a cylindrical object the central axis of which is perpendicular to the plate-plane. This disparity arises from the fact that the serioscope does not correct the enlargement of each planeogram delineated, nor does it correct the displacement.

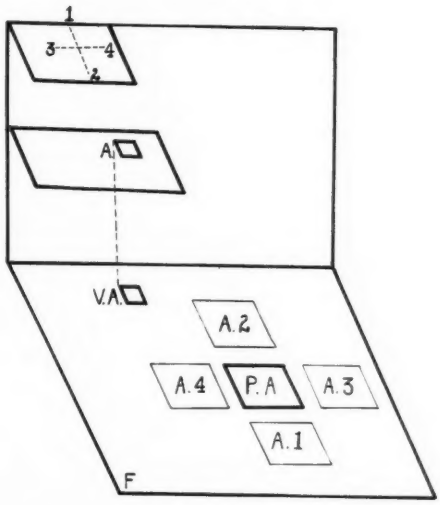

Fig. 1. (1) *A*. represents a plane section through an object in space.
(2) *A*.1 and *A*.2 represent stereoscopic films taken with axis shift 1....2.
(3) *A*.3 and *A*.4 represent stereoscopic films taken with axis shift 3....4.
(4) Stereoscopic Axes 1....2 and 3....4 are perpendicular to each other and bisect each other.
(5) *V.A*. represents a vertical projection of *A*.
(6) *F*. represents the mounting of the four stereoroentgenograms in the serioscope.
(7) *P.A*. represents the planeogram of *A*., produced by superimposing *A*.1, *A*.2, *A*.3, and *A*.4, by means of the serioscope.
(8) Note that the planeogram, *P.A*., is larger than its homologous object-plane, *A*. Note also its displacement from its true position, *V.A*.

If plane, *B*, represents a rib, and plane, *A*, a cavity, serioscopic images *P.B*. and *P.A*., of Figure 3, would represent the plane images of rib, *B*, and cavity, *A*. One would get the impression from the serioscope that the cavity does not lie vertically above the rib but to the side. The surgical approach under these circumstances would necessarily be wrong. It is true that the serioscope would give the correct vertical distances separating these planes, but the alignment of one above the other would be faulty.

From the above we see that, by the serioscope, successive pictures of object-planes can be delineated, and that the depths separating the object-planes so delineated

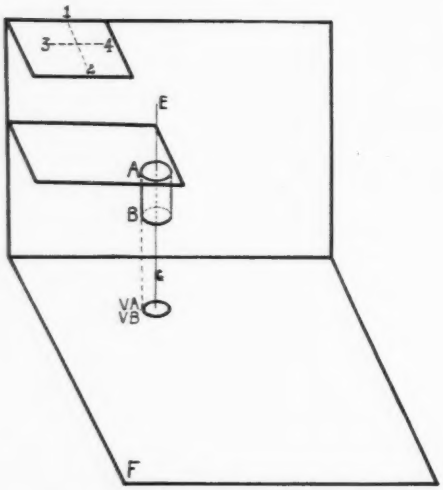

Fig. 2. Cylinder *A*...*B* lies in space above the plane of the film surfaces, *F*, so that its superior surface, *A*, and inferior surface, *B*, are parallel to *F*, and so that its central axis, *E*...*G*, is perpendicular to *F*. *V.A.* and *V.B.* represent the vertical projections of *A* and *B* superimposed.

Four exposures of cylinder *A*...*B* are made from focal positions, 1, 2, 3, and 4, for serioscopy (see Fig. 2-*A*).

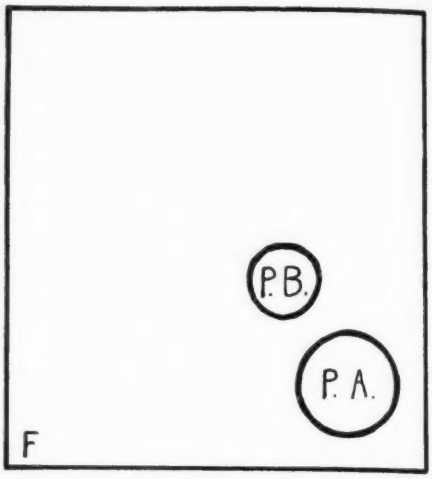

Fig. 2-*A*. (1) *P.A.* represents the planeographic images of superior surface *A*, of the cylinder pictured in Figure 2.

(2) *P.B.* represents the planeographic image of inferior surface, *B*, of the cylinder pictured in Figure 2.

(3) Note that both *P.A.* and *P.B.* are disproportionately larger than their homologous planes, *A* and *B*, and that in the serioscope they do not overlie each other as they do in the cylinder, *A*...*B*. If *A* and *B* represented anatomical structures, the surgeon would get a wrong impression of the size of the object from serioscopic images *P.A.* and *P.B.* Also he would get the impression that *A* lies to the side of *B* rather than over it. By examining all the planeograms successively from *P.B.*...*P.A.*, he would get the impression that the object portrayed was a truncated cone the central axis of which was oblique to the film surface rather than a cylinder the axis of which was perpendicular to this surface.

may be read in centimeters. The picture planes, however, are disproportionately enlarged when compared to homologous object-planes and they do not overlie each other in the same alignment as the object-planes. For any surgical procedure which requires localization, or mensuration, serioscopy accordingly is inadequate. Under these circumstances, special corrective measures, as suggested by us (3, 4, 5), must be employed.

The above dissertation on serial planeography applies equally as well to serial planigraphic studies.

SUMMARY

(1) By planigraphy and similar procedures it is possible to obtain a roentgenographic film of a designated object-plane (body section).

(2) Planeography is a procedure introduced by us as an original method by which, from two or more standard roentgenograms, films of all the object-planes may be delineated. Localization, mensuration, plane reconstruction, and object reconstruction are all made possible by this method.

(3) The basic principles employed in the serioscopy of Cottenot are those previously elaborated by us under the term "planeography." Successive plane films of object-planes may be delineated by this method. Also the depths between the object-planes so delineated may be measured, but this measurement has no real value.

(4) The limitations of serial planeography (serioscopy) are critically analyzed. It is shown that by serioscopy one gets an erroneous impression of the true size, shape, and relative position of the object so studied.

(5) The limitations of serial planeography apply as well to serial planigraphic studies.

(6) Corrective measures, as suggested by us, may be applied to obviate the difficulties of serial planeography (serioscopy) and serial planigraphy.

REFERENCES

(1) ANDREWS, J. R.: Planigraphy: Introduction and History. Am. Jour. Roentgenol. and Rad. Ther., **36,** 575–587, November, 1936.

(2) MOORE, SHERWOOD: Body Section Roentgenography with Laminagraph. Am. Jour. Roentgenol. and Rad. Ther., **39,** 514–522, April, 1938.

(3) KAUFMAN, JULIUS: Planeography, Localization, and Mensuration: "Standard Depth Curves." RADIOLOGY, **27,** 168–174, August, 1936.

(4) Idem: The Planeogram: Analysis and Practical Application, with Especial Reference to Mensuration of the Pelvic Inlet. RADIOLOGY, **27,** 732–735, December, 1936.

(5) Idem: Object Reconstruction by Planigraphy: Reconstruction and Localization of Planes. RADIOLOGY, **30,** 763–765, June, 1938.

(6) COTTENOT, PAUL: Thoracic Serioscopy: Method of Study for Pleuro-pulmonary Lesions. RADIOLOGY, **31,** 1–7, July, 1938.

THE PHYSICIAN-HOSPITAL PROBLEM

The following letter written by Thomas A. Groover, M.D.,[1] to the Secretary of the Inter-Society Committee is of such widespread interest that Dr. Groover's permission to publish it has been secured.

The views of other readers on the topic of hospital relationships will be welcome. The members of the Inter-Society Committee would appreciate receiving comments from members who feel they have something to add to a consideration of the problem. The letter follows:

"MY DEAR CAHAL: Many thanks for your letter of December 20 reminding me of a promise to you and Ed Chamberlain to set down some of the thoughts which I expressed at our recent conference in Atlanta regarding the physician-hospital relationship problem in which radiologists are particularly interested.

"Before attempting to do so, first, let me say that I think you rightly assume it to be at least part of your function as Executive Secretary of the American College of Radiology to help interpret the specialty to the public and to groups of physicians organized along lines similar to the one you represent. You rightly also regard it as your responsibility to interpret to the medical profession the concepts of the man in the street. To discharge such obligations is a whale of a job. It is one that invites sniping from all sides and requires a superabundance of imperturbability to carry on with it. Probably all of us are opportunists in varying degree and for that reason the gospel of a practical idealism which you are presumed to preach makes yours a most discouraging task. Now, I am about to lay on your doorstep another idea to interpret.

"It is chock-full of dynamite but I believe it is fundamental to a reasonable understanding of the physician-hospital problem.

"I think that the problem itself has been in the making for some time but is only just beginning to assume a recognizable form. It is born of the rapid institutionalization of medicine in recent years which still continues at an unabated pace. It should be remembered that the hospital was originally an institution only for the indigent and was commonly an annex to the almshouse and prison. Under such circumstances it was natural for the doctor to expect others to furnish the necessary shop, tools, and assistants to enable him to function in the hospital, particularly in view of the fact that his own indispensable service was rendered gratuitously. In those days those who were economically competent never thought of patronizing the hospital as patients. Later on when their prejudice against doing so was broken down and they began to patronize hospitals as patients, the hospitals continued to furnish the doctor, without charge to him, a shop in which to work; the tools of his trade, and a corps of professional and technical assistants. Prior to this time the doctor had furnished these items himself in caring for the economically competent. Obviously this circumstance places the doctor in a very vulnerable position with respect to his control of hospital policies. As hospitals continue to occupy an increasingly dominant position in the medical field, concurrently with an increasing institutionalization of medicine, the doctors' influence in controlling their policies may reasonably be expected to dwindle proportionately. As a corollary of the latter statement it is logical to conclude that the 'fee for service' system of medical practice will decrease, and the 'wage for service' system will increase. I think that this trend is now apparent in many departments of medicine—obviously so in radiology—and I believe that many adherents of the fee for service system in all departments of medicine will be drawn into the opposing group and still larger numbers will quite naturally grow up in it.

"To state the problem in a somewhat different way, I envision the hospitals as representing the capitalists of medicine, and would regard it as passing strange if they do not more and more adopt the capitalistic technic. By the latter I mean more particularly that increasing pressure will be exerted to hire professional help just as they do non-professional.

[1] Just after closing the forms for this issue, word was received of Dr. Groover's death.

Certainly the present differential in the doctor's favor will in one way or another be wiped out.

"Assuming now that a large segment of the medical profession recognizes and views adversely the trend I have tried to indicate, it may well be asked what, if anything, can they do to modify it. To such, I would have them remember that it is their prerogative to operate their own shop. In other words, they can form a competing capitalistic group. There is abundant evidence to indicate that this is not an altogether fantastic idea or impractical task. If undertaken seriously it may well have a far-reaching and salutary effect both for the medical profession and the public.

"In the above brief commentary on the physician-hospital problem I trust that you will particularly note that it is not tinged with partisanship or special pleading. I have purposely refrained from even mentioning many highly important issues and implications which the basic theme suggests, feeling that to do so might obscure rather than clarify the latter. I would be glad to discuss some of the former with you when the opportunity offers.

"Sincerely yours,

[*Signed*] "THOMAS A. GROOVER."

RADIOLOGICAL SOCIETIES IN NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

UNITED STATES

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles; *Secretary,* Carl D. Benninghoven, M.D., 95 S. El Camino Real, San Mateo.

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Pacific Roentgen Club.—Chairman, Karl M. Bonoff, M.D., Los Angeles; *Members of Executive Committee,* I. S. Ingber, M.D., A. C. Siefert, M.D., D. R. MacColl, M.D.; *Secretary-Treasurer,* L. Henry Garland, M.D., 450 Sutter St., San Francisco. Executive Committee meets quarterly; Club meets annually during annual session of the California Medical Association.

San Francisco Radiological Society.—Secretary, Harold A. Hill, M.D., 450 Sutter Street. Meets monthly on third Thursday at 7:45 P.M., for the first six months at Toland Hall (Univ. of Calif. Med. School) and for the second six months at Lane Hall (Univ. of Stanford Med. School).

COLORADO

Denver Radiological Club.—President, N. B. Newcomer, M.D., 306 Republic Bldg.; *Vice-president,* Elizabeth Newcomer, M.D.; *Secretary,* Paul R. Weeks, M.D., 520 Republic Bldg.; *Treasurer,* L. G. Crosby, M.D., 366 Metropolitan Bldg. Meets third Friday of each month at homes of members.

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Illinois State Medical Society, Section on Radiology.—The next meeting will be in Peoria, May 21–23, 1940. The officers are: *Chairman,* Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago; *Secretary,* Harry W. Ackeman, M.D., 321 W. State St., Rockford.

INDIANA

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MAINE

See New England Roentgen Ray Society.

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The St. Louis Society of Radiologists.—President, Oscar C. Zink, M.D., St. Luke's Hospital; *Secretary,* Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

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NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, P. S. Avery, M.D., Middlesex Hospital, New Brunswick; *Vice-president,* J. G. Boyes, M.D., 912 Prospect Ave., Plainfield; *Treasurer,* H. A. Vogel, M.D., 1060 E. Jersey St., Elizabeth; *Secretary,* W. James Marquis, M.D., 198 Clinton Ave., Newark; *Counsellor,* A. W. Pigott, M.D., Skillman. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

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Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President,* Archie Fine, M.D., 707 Race St., Cincinnati; *Secretary-Treasurer,* Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, Louis A. Milkman, M.D., Medical Arts Bldg., Scranton; *First Vice-president,* James E. Ginter, M.D., Dubois; *Second Vice-president,* Alexander Stewart, M.D., Shippensburg; *Secretary-Treasurer,* L. E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect,* Harvey N. Mawhinney, M.D., 6546 Darlington Road, Pittsburgh; *Editor,* William E. Reiley, M.D., Clearfield; *Assistant Editor,* Sydney J. Hawley, M.D., Danville. Next annual meeting to be held May 17 and 18, 1940, at Hershey Hotel, Hershey, Pa.

The Philadelphia Roentgen Ray Society.—President, Joseph E. Roberts, Jr., M.D., 403 Cooper St., Camden, N. J.; *Vice-president,* Jacob H. Vastine, M.D., Medical Arts Bldg., Philadelphia; *Secretary,* Barton R. Young, M.D., Temple University Hospital, Philadelphia; *Treasurer,* Fay K. Alexander, M.D., Chestnut Hill Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—President, Zoe A. Johnston, M.D., 601 Jenkins Arcade; *Vice-president,* Prentiss A. Brown, M.D., and *Secretary-Treasurer,* Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, T. A. Pitts, M.D., Columbia; *Secretary-Treasurer,* Malcolm Mosteller, M.D., Columbia Hospital, Columbia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—President, Steve W. Coley, M.D., Methodist Hospital, Memphis; *Vice-president,* Eugene Abercrombie, M.D., 305 Medical Arts Bldg., Knoxville; *Secretary-Treasurer,* Franklin B. Bogart, M.D., 311 Medical Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, C. F. Crain, M.D., Corpus Christi; *President-elect,* M. H. Glover, M.D., Wichita Falls; *First Vice-president,* G. D. Carlson, M.D., Dallas; *Second Vice-president,* P. E. Wigby, M.D., Dallas; *Secretary-Treasurer,* L. W. Baird, M.D., Scott and White Hospital, Temple. Meets annually. The next annual meeting is to be Jan. 18, 1941, in Sherman.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president,* L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary,* V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Vice-president,* George Cornett, M.D., Yakima; *Secretary-Treasurer,* Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—President, H. W. Hefke, M.D.; *Vice-president,* Frederick C. Christensen, M.D.; *Secretary-Treasurer,* Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—*Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

Section on Radiology, Canadian Medical Association.—*Chairman*, Gordon Richards, M.D., Medical Arts Bldg., Toronto; *Secretary*, W. J. Cryderman, M.D., Medical Arts Bldg., Toronto.

Section on Radiology, Ontario Medical Association.—*Chairman*, E. H. Shannon, M.D., St. Michael's Hospital, Toronto; *Secretary*, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

Canadian Association of Radiologists.—*President*, J. E. Gendreau, M.D., Montreal; *Vice-president*, W. H. McGuffin, M.D., Calgary; *Honorary Secretary-Treasurer*, W. L. Ritchie, M.D., Montreal; *Chairman of Interrelations Committee*, G. E. Richards, M.D., Toronto.

The Eastern Canada Mid-winter Session was held on Jan. 6, 7, and 8, 1940. Thirty radiologists from Halifax, Ottawa, Montreal, Toronto, London, Oshawa, Kingston, and St. Catherine's met with their colleagues in Quebec in several hospitals of the Old City of Champlain to discuss scientific problems and to attend to their professional interests.

The following is a listing of the papers presented on that occasion:

Treatment of Carcinoma of the Tongue. Dr. J. E. Gendreau and Dr. O. Dufresne, Montreal.

Gallstone and Medication. Dr. L. Minto, Montreal.

Seriescopy. Dr. J. Gosselin, Quebec.

Primary Tumors of Bone. Dr. M. C. Morrison, London.

The Radiologic Exploration of the Mucosal Relief of the Stomach. Dr. Albert Jutras, Montreal.

A Comparison of Clinical X-ray and Operative Findings in Sinusitis. Dr. G. Hilton and Dr. E. M. Crawford, Montreal.

Wartime Radiology. Dr. Edmour Perron, Quebec.

Treatment of Carcinoma of the Tongue. Dr. G. E. Richards, Toronto.

Calcium Metabolism and Radiography of Bone. Dr. J. Bouchard, Dr. A. R. Potvin, and Dr. L. R. Payeur, Quebec.

The Roentgenologic Anatomy of the Chest. Dr. C. B. Pierce, Montreal.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

THE FUTURE OF THE RADIOLOGIST

The term *radiologist* should, first of all, indicate a capable, well trained physician who has, in addition, mastered the art and science of radiology which he intelligently applies to both diagnosis and therapy to the fullest extent of its development. It is now well established that such a training is parallel with that of a surgical training, and requires a minimum of three years, to be spent with a physician or group of physicians who have a large clientele of radiologic cases. This training apparently should qualify a physician for the specialty of radiology. However, when we consider the broadness of the radiologic field and its intimate relation with all other specialties, it is reasonable to assume that such a training is only preparation for a radiologic practice. Then what of the future? How are we to maintain our position as consultants in all the specialties, as well as desirable consultants for the general practitioners? It seems to me the future presents a problem of equal importance to the preliminary training.

The careful reading of all the special journals is obviously necessary if the radiologist is to keep abreast with the developments in medicine; particularly is this true of all articles which have a bearing on diseases and organs which can be examined roentgenographically and treated by roentgen therapy. This, however, is not in itself sufficient. We are still consultants in the opinion of our confrères and to maintain such a status it will be necessary to keep abreast with the developments of all the special branches of medicine if we wish to be indispensable consultants instead of radiographers with a laboratory. With such a background, no radiologist need fear the lack of referring doctors who want his opinion and who feel that the expense of such an examination is perfectly reasonable, nor need there be fear of competition from the untrained physician who buys an x-ray machine for his office.

Perhaps it might appear reasonable that the specialists could best qualify themselves individually in radiology and thereby conduct their own radiologic examinations. However, this usually is not practical. First, the capable radiologist is the consultant for a number of specialties in the same field and has access to a much greater number of cases than the individual specialist. This gives him a much broader experience. Second, roentgen examination will often reveal lesions which overlap the special fields of medicine. As an example, examination of a patient with low back pain may reveal the presence of a ureteral stone, a pathologic gall bladder, a tumor in the pelvis, an aneurysm of the renal artery, a kidney tumor, a bone lesion of the lumbar spine, a tumor of the spinal canal, or many another abnormal change which may be responsible for the patient's symptoms. One or several of these conditions may be present in the same individual.

Who, in your opinion, from the patient's standpoint, would be most capable to make an accurate diagnosis by the roentgen ray? The answer is a well trained radiologist. For example, such an examination may be undertaken by an orthopedist because of the fact that the patient has low back pain or symptoms referable to the spine. After such an examination, conducted wholly by the orthopedic surgeon, the presence of a definite osteoarthritis may be considered sufficient to account for the symptoms. Well planned treatment for arthritis or proper orthopedic support for such a back may not relieve the symptoms because of the presence of a ureteral calculus which may easily be overlooked by the physician not trained in the specialty of urology. Likewise, the suspension of a ptosed kidney will not relieve the symptoms due to an

early osteogenic sarcoma of the lumbar spine. Such reasoning can be applied to a large group of patients and it is obvious to us that a capable radiologist can render the best and most efficient service to such patients.

It is rather amusing to read in *Medical Economics* for January, 1940, a paper entitled "X-ray for the General Practitioner." The author reports opinions of various physicians throughout the country. Quoting the opinion of a number of physicians, he states, "Fees charged by local roentgenologists are too high. The patients desire a break." Also, that the general practitioner can get an x-ray in his office much quicker than by referring his patient to the radiologist, and if cases in his office average ten or more a month, the equipment will pay its way. Another physician states, "Rightfully or not, the physician is judged by his equipment." We ask, does this mean physical or professional equipment? This author also quotes a physician who advised a group of doctors to buy x-ray equipment and to have in the group one doctor who has more than a superficial grasp of x-ray procedure and diagnosis, as much can be learned from such a man.

It is most unfortunate, however, that many doctors consider buying an x-ray machine all that is necessary for the practice of this specialty. To me, this seems to be comparable to the physician who purchases a set of surgical instruments as the preparation for a practice in surgery without proper training in the specialty. It is evident, however, that such attempts of practice without proper preparation usually will be understood by the more intelligent layman and by the conscientious doctor who wishes to render the best service to his patients.

In retrospect, I think this entire discourse is well borne out by the fact that the leading pioneers in radiology were all competent, well trained physicians as well as capable radiologists.

B. H. NICHOLS, M.D.

Cleveland Clinic, Cleveland, Ohio

ANNOUNCEMENTS

AMERICAN RADIUM SOCIETY

The following has been received from the Secretary of the American Radium Society:

To the Members of the American Radium Society: April 10, 1940

Applications for membership in the American Radium Society have been received by the Executive Committee from the following:

Name	Address	Recommended by
Allen, Dr. Kenneth	452 Metropolitan Bldg. Denver, Colorado	Dr. W. E. Costolow Dr. F. H. Rodenbaugh
Baker, Dr. E. C.	Youngstown Hospital Youngstown, Ohio	Dr. Lawrence Pomeroy Dr. James R. Driver
Farrow, Dr. Joseph	Memorial Hospital New York City	Dr. James Ewing Mrs. Edith Quimby
Flynn, Dr. James M.	277 Alexander Street Rochester, New York	Dr. E. H. Skinner Dr. William P. Healy
Hagans, Dr. Frank M.	400 Broadway Street Lincoln, Illinois	Dr. Frank Simpson Dr. Max Cutler
Hahn, Dr. George Alan	American Oncologic Hosp. Philadelphia, Pa.	Dr. G. M. Dorrance Dr. William S. Newcomet
Hall, Dr. Wendell C.	179 Allyn Street Hartford, Conn.	Dr. D. J. Roberts Dr. R. T. Ogden
Hildreth, Dr. R. C.	420 S. Rose Street Kalamazoo, Michigan	Dr. R. H. Stevens Dr. Hayes Martin
Hocker, Dr. Alfred F.	140 East 54th Street New York City	Dr. William MacComb Dr. Hayes Martin
Holding, Dr. Arthur T.	142 Washington Ave. Albany, New York	Dr. Douglas Quick Dr. Hayes Martin
Jaffe, Dr. Henry L.	104 S. Michigan Ave. Chicago, Illinois	Dr. Angus K. Wilson Dr. Max Cutler
Jorstad, Dr. Louis H.	3720 Washington Blvd. St. Louis, Missouri	Dr. A. N. Arneson Dr. Fred J. Taussig
McCormick, Dr. Norman A.	1687 Wyandotte St., East Windsor, Ontario	Dr. Douglas Quick Dr. William P. Healy

McNeer, Dr. Gordon P.	Memorial Hospital New York City	Dr. George T. Pack Dr. William MacComb
Pompa, Dr. Alfred M.	220 N. First Street Boise, Idaho	Dr. D. T. Quigley Dr. Howard Hunt
Rubenfeld, Dr. Sidney	55 East 86th Street New York City	Dr. Ira I. Kaplan Dr. William H. Cameron
Schmitz, Dr. Herbert E.	25 East Washington St. Chicago, Illinois	Dr. John S. Bouslog Dr. Zoe A. Johnston
Taft, Dr. Robert	103 Rutledge Ave. Charleston, So. Carolina	Dr. Zoe A. Johnston Mrs. Edith Quimby
Young, Dr. James R.	Professional Bldg. Anderson, So. Carolina	Dr. William S. MacComb Dr. Hayes Martin

Any objections held by members against such applicants should be sent to the Chairman of the Executive Committee (Dr. Zoe Allison Johnston, 601 Jenkins Arcade, Pittsburgh, Pennsylvania) as soon as possible, in accordance with Section A of Article 3 of the By-laws of the Society.

Very truly yours,

EXECUTIVE COMMITTEE

Zoe Allison Johnston, M.D., *Chairman*
Edward H. Skinner, M.D.
William P. Healy, M.D.

A NEW PUBLICATION

The Hospital for Joint Diseases of New York City announces the publication of the *Bulletin*, which will be devoted to recording material of orthopedic interest from the experience of its clinical and laboratory divisions. The *Bulletin* will serve as a medium for presenting skeletal diseases studied within their proper framework of medical science as a whole rather than viewed through the limited aspect of any one specialty.

For many years, the staff physicians of the Hospital have been engaged in clinical investigation, research, and surgical studies of a wide variety of orthopedic conditions. Much of this material has in the past become submerged in the mass of hospital records and remains unpublished. These experiences are instructive, may represent frontiers of knowledge, and merit a permanent record. The *Bulletin* is intended as a vehicle for these experiences. The Editor is Samuel Kleinberg, M.D.

RADIOLOGY greets this new publication and wishes it a long and useful life.

AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS

The Twenty-fifth Annual Meeting of the American Association of Industrial Physicians and Surgeons, together with the First Annual Meeting of the American Industrial Hygiene Association, will be held at Hotel Pennsylvania, New York City, June 4 to 7, 1940. This will be a four-day meeting intensively devoted to the problems of industrial health in all of their various medical, technical, and hygienic phases, with particular stress on prevention and control of occupational hazards.

The medical profession is not only invited, but urged to attend these gatherings as they will be of unusual interest and value to all practitioners interested in industrial injuries and illnesses.

IN MEMORIAM

HOWARD EDWIN RUGGLES, M.D.
(1886–1939)

Howard Ruggles was born in San Francisco, where he received his early education and spent the major portion of his so short but brilliant life. On Dec. 28, 1939, in his country home near there, he suddenly passed away.

After receiving a Bachelor Degree from Stanford University in 1907, he entered the Harvard School of Medicine and, graduating in 1913, he returned to San Francisco, where he quickly became a leader in his chosen profession, roentgenology.

While at Harvard he was fortunate in his association with his teacher, Dr. George Holmes, and from this arose a deep and lasting friendship which he cherished to the last, and their combined efforts produced an outstanding textbook of roentgenology which is now a standard throughout the world.

Dr. Ruggles' first appointment was to St. Luke's Hospital, where he remained as Visiting Roentgenologist until his death. In 1914 he received an appointment at the University of California and rapidly rose to the head of the Department of Roentgenology, where he held the title of Clinical Professor. He was also Chief Consultant to the Shriners Hospital,

The late HOWARD EDWIN RUGGLES, M.D.

Children's Hospital, Southern Pacific Hospital, and the University of California Service at the City and County Hospital of San Francisco. During the World War he served in France as a captain attached to Base Hospital No. 30.

He was a member of his local county and state medical societies and of the American Roentgen Ray Society, of which he was a Vice-president, Chairman of the Publication Committee, and a member of the Executive Council.

Like many of the pioneers in roentgenology, he devised and built several pieces of original apparatus which are still in use, namely, the tilting fluoroscope and the Ruggles Sinus Device. Early in the 1920's he constructed a practical device for moving roentgenograms of the heart in spite of comparatively inefficient tubes and films.

His primary interest was in diagnosis rather than in therapy; his skill as a technician was unsurpassed and his diagnostic ability was rapier-like in its swiftness and accuracy.

He was a master teacher and those of us who were fortunate enough to come under his

wing can at last realize what a rare opportunity was ours and bow our heads in reverence to our "Chief."

He had little interest in outdoor sports and his hobby was photography, particularly in colored moving pictures, of which he developed a wonderful collection. This collection was the delight of many friends and the envy of professionals.

His generosity even in a material sense to the younger roentgenologists was well known to many but was made light of by Howard.

The science of roentgenology owes him a great debt, for its advancement, particularly on the Pacific Coast, is due in no small measure to his skill, his thoroughness, his inspiration, his enthusiasm, and his not numerous but important contributions to the literature. If by your work you shall be known, then the name of Howard Ruggles will indeed endure.

LLOYD BRYAN, M.D.

San Francisco

THOMAS A. GROOVER, M.D.

The message has just been received of the passing of Dr. Thomas A. Groover, of Washington, D. C., one of the country's eminent radiologists. A full notice is being prepared, to be published in the next issue of RADIOLOGY.

We have also received word of the death, on March 12, of Edward M. Heacock, M.D., of Chicago, and, on March 24, of Erwin W. Johns, M.D., of Albuquerque, New Mexico.

The friends of these late members of the Society will mourn their death.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

RADIODIAGNOSTICO. Tomo I.—Fisica de Los Rayos X Aparatos (Radiodiagnosis. Volume I.—Physics of the X-rays—Apparatus). By Dr. GONZALO ESGUERRA GOMEZ, of the Faculty of Medicine, National University, Bogota, Colombia. A volume of 115 pages, with 80 illustrations by Dr. Roberto Ezpeleta. Cromos, Bogota, Colombia, 1938.

RADIODIAGNOSTICO. Tomo II.—Systema Oseo (Radiodiagnosis. Volume II.—Osseous System). By Dr. GONZALO ESGUERRA GOMEZ, of the Faculty of Medicine, National University, Bogota, Colombia. A volume of 335 pages, with 400 illustrations. Cromos, Bogota, Colombia, 1938.

WIDE FIELD X-RAY TREATMENT: The Value of the X-ray Bath Method in Disease and Health. By S. GILBERT SCOTT, M.R.C.S., L.R.C.P., F.F.R., D.M.R. and E. (Camb.), Consulting Radiologist to the London Hospital; Honorary Radiologist to the British Red Cross Rheumatism Clinic, London; Honorary Physician-radiologist to the Charterhouse Rheumatism Clinic. A volume of 80 pages, with 13 figures. Published by George Newnes, Ltd., London, 1939. Price: 8 shillings six pence.

PRINCIPLES OF ROENTGENOLOGICAL INTERPRETATION. By L. R. SANTE, M.D., Professor of Radiology, St. Louis University School of Medicine; Radiologist to St. Louis City Hospital and St. Mary's Hospital, St. Louis. A volume of 340 pages, with numerous illustrations. Published by Edwards Brothers, Inc., Ann Arbor, Mich., 1940. Price: $5.50.

STECKSCHUSS UND RÖNTGENSTRAHLEN (Embedded Projectiles and the Roentgen Rays: Examination and Treatment). By Prof. Dr. RUDOLF GRASHEY, Köln. A monograph consisting of 92 pages, with 80 illustrations. Published by Georg Thieme, Leipzig, 1940. Price: 8.70 R.M. (25 per cent discount allowed to foreign purchasers).

DIRECTORY OF MEDICAL SPECIALTIES, Certified by American Boards, 1939. Paul Titus, Directing Editor, and J. Stewart Rodman, Associate Editor. A volume of 1573 pages. Published by Columbia University Press, Morningside Heights, New York City, 1940. Price: $5.00.

AN INTRODUCTION TO GASTRO-ENTEROLOGY. Third Edition of "The Mechanics of the Digestive Tract." By WALTER C. ALVAREZ, M.D., Professor of Medicine, University of Minnesota, The Mayo Foundation, and a Senior Consultant in the Division of Medicine, The Mayo Clinic. A volume of 778 pages, with 186 illustrations. Published by Paul B. Hoeber, Inc., New York City, 1939. Price: $10.00.

PNEUMOCONIOSIS (SILICOSIS): THE STORY OF DUSTY LUNGS. A Preliminary Report. By LEWIS GREGORY COLE, M.D., Director of Silicotic Research, John B. Pierce Foundation, New York City, and WILLIAM GREGORY COLE, M.D., New York City. A volume of 290 pages, with 26 illustrations. Published by John B. Pierce Foundation, New York City, 1940. Price not stated.

HEPATOLIENOGRAPHIE MIT JODSOL (HEPATOLIENOGRAPHY WITH IODOSOL). By Dr. FRANZ BECKERMANN, Associate Physician at the Hamburg-Eppendorf Clinic. A monograph consisting of 88 pages, with 65 illustrations. Published by Georg Thieme, Leipzig, 1940. Price: 8 R.M. (25 per cent discount allowed to foreign purchasers).

BOOK REVIEWS

TUMORS OF THE SKIN. By JOSEPH JORDAN ELLER, M.D., Attending Dermatologist, City Hospital, New York City; Consulting Dermatologist: French Hospital, Broad Street Hospital, New York; Morristown Memorial Hospital, Monmouth Memorial Hospital, Fitkin Memorial Hospital, New Jersey; Norwalk General Hospital, Connecticut; Unity Hospital, Brooklyn; Morelos Hospital, Mexico, etc. A volume of 607 pages, with 403 illustrations. Published by Lea & Febiger, Philadelphia, 1939. Price: $10.00.

This specialized book discusses tumors of the skin under the usual classification of benign and malignant lesions. A chapter is devoted to surgical procedures and plastic repair, and there is an appendix on the subject of the physical aspects of radiation.

The material on benign lesions of the skin comprises 246 pages. In this section there are many excellent cuts, both of anatomic and histo-pathologic specimens. Although one might question the accuracy of the histo-pathologic diagnosis as revealed by certain illustrations, this is perhaps a problem for the concern of the histo-pathologist rather than for the radiologist. The use of reports of cases in connection with Von Recklinghausen's disease might be considered superfluous because of the relative unimportance of this disease.

That portion of the book concerned with malignant tumors of the skin comprises 244 pages of which considerable space is devoted to radiation therapy with particular emphasis on radium. The illustrations showing the author's method of applying radium are particularly good.

The chapter on "lymphomas" is important in that it emphasizes the fact that cutaneous eruptions in "lymphoma" are generally a manifestation of systemic disease. In this connection the use of the term "lymphocytomas" may be criticized because the term is not in general use. Most workers look upon these tumors as being, possibly, lymphoblastomas.

The chapter on methods of cutaneous surgery and plastic repair offers many helpful hints, together with figures illustrating various technics.

The last portion of the book is concerned with roentgen physics and biologic aspects. It is perhaps open to criticism because it deals with comparisons of depth dosages of "moderate" and so-called "high voltage" (200 kv.) roentgen rays. These considerations, together with the various charts of surface and depth dosages that are presented, although scientifically true, lie in the realm of the therapeutic roentgenologist rather than that of the dermatologist. In the appendix the chart indicating the standardization of a machine listed as "XYZ" gives the control setting as well as the voltage readings. It is generally accepted that the control settings are unimportant, the only important factors being the voltmeter pre-reading and the peak kilovoltage.

The various chapters contain an extensive bibliography which should be helpful in reference work. This very readable book will find its place as a valuable addition to the library of the dermatologist rather than the roentgenologist, since it contains a wealth of information on tumors of the skin which is discussed in more detail than in most texts on dermatology.

ORTHOPEDIC OPERATIONS. By ARTHUR STEINDLER, M.D., F.A.C.S., Professor of Orthopedic Surgery, State University of Iowa, Iowa City, Iowa. A volume of 766 pages, with numerous engravings, graphs, and tables. Published by Charles C. Thomas, Springfield, Illinois, 1940. Price: $9.00.

This volume, by a distinguished teacher of orthopedic surgery, is a welcome addition to the literature on this subject. The title page reads, "Orthopedic Operations, Indications, Technic, and End-results." The author has followed this program closely, and, therefore, has produced a book somewhat different from those previously published. The work is divided into three parts as follows: first, General Biologic, Anatomic, Pathologic, and Clinical Topics pertaining to Orthopedic Operations; second, The Technic of Orthopedic Operations, and third, The Indications and End-results. In this respect again the author has hit upon a new plan of presentation and one which it seems will be pleasing to his readers.

As the author states, the book is submitted "as a final account of the writer's experience in several phases of orthopedic treatment" and, therefore, cannot cover every phase of the subject. However, we were pleased to see a wide variety of operations presented, perhaps

another indication of the author's very broad experience. These operations are well presented, well illustrated by drawings by the author's own artist, and adequately described with the added important advantage that, in many instances, the tables of end-results of the author's own experience are given, and these are an unusually valuable adjunct to the work and should prove a great aid to the surgeon in selecting an operation for his particular need.

The book is well illustrated and beautifully printed, with a good bibliography, and should prove a valuable asset to the library of anyone interested in operations commonly used in bone and joint surgery.

THE RADIOLOGY OF PULMONARY TUBERCULOSIS. By J. E. BANNEN, M.B., Ch.B., D.M.R.E. A volume of 156 pages, with 39 illustrations. Published by William Wood and Company, Baltimore, 1938. Price: $4.50.

In some seventy pages of text the author attempts to discuss the pathogenesis, clinical features, radiology, differential diagnosis, and collapse therapy of pulmonary tuberculosis, together with a chapter on pneumoconiosis. The result is a rather superficial discussion which touches lightly on modern concepts of tuberculosis, while the roentgen features are inadequately covered. The ideas expressed are orthodox, but frequently too dogmatic, due, no doubt, to limitations of space. A good feature of the book is the emphasis placed upon atelectasis, an important factor in the pathogenesis and roentgen findings of pulmonary tuberculosis. There is a chapter on the technic of roentgen examination in which thickness-of-part technic is but casually mentioned. Fluoroscopy is rightly deplored as a means of diagnosing minimal lesions, but the author does not point out that this method is more effective than the roentgenographic procedure in the detection of calcified foci or calcified glands. A number of statements may well be questioned. Surely, a primary focus does not invariably show on a roentgenogram throughout life. Likewise, the emphasis on the production of calcium shadows in adult lesions seems unjustified. The statement that tuberculous cavities do not contain fluid may lead the unwary reader into error.

The illustrations are printed on good paper but are not of good quality. The arrangement is unsatisfactory and in several instances, notably Figures 11-*B* and 12-*B*, Figures 17 and 18, the same roentgenogram is repeated for no apparent reason. It is difficult to believe that the rounded mass with convex outer borders, shown in Figure 11-*A*, could represent an atelectasis of the lower lobe from bronchial obstruction as described in the legend. While the author has presented in brief form a reasonably accurate statement of some of the important facts about pulmonary tuberculosis, he falls short of an adequate treatment of the radiology of this disease.

ABSTRACTS OF CURRENT LITERATURE

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MAX CLIMAN, M.D., of Hartford, Conn.
Q. B. CORAY, M.D., of Salt Lake City, Utah
JOSEPH T. DANZER, M.D., of Oil City, Penna.
PERCY J. DELANO, M.D., of Chicago
W. H. GILLENTINE, M.D., of New Orleans, La.
SYDNEY J. HAWLEY, M.D., of Danville, Penna.
HANS W. HEFKE, M.D., of Milwaukee, Wisc.
JOHN B. MCANENY, M.D., of Madison, Wisc.
ANTONIO MAYORAL, M.D., of New Orleans, La.
JOHN M. MILES, M.D., of Lafayette, La.
LESTER W. PAUL, M.D., of Madison, Wisc.
SIMON POLLACK, M.D., of St. Louis, Mo.
ERNST A. SCHMIDT, M.D., of Denver, Colo.

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DOSAGE

Experimental Investigations on the Importance of Protraction and Fractionation. Börge Faber. Acta Radiol., **20,** 170–184, April, 1939.

By a decrease of daily radiation doses, *i.e.*, increased fractioning, from 225 r to 150 r, the author was able to demonstrate an increase in the skin tolerance of approximately 30 per cent. A protraction from 20 r/min. to 2.5 r/min. increased the skin tolerance a further 10 or 15 per cent. These experiments were done in guinea pigs; the total doses applied varied from 3,000 to 6,000 r. Very interesting is a table by Reisner which shows that considerably larger doses can be applied *in toto* by fractioning and protraction. According to this table, the same erythema is produced by daily irradiations with the following individual doses (the skin erythema dose is expressed by S.E.D.):

10% S.E.D. 27 times = 270% S.E.D. in 27 days
20% S.E.D. 12 times = 240% S.E.D. in 12 days
30% S.E.D. 7 times = 210% S.E.D. in 7 days
40% S.E.D. 4 times = 160% S.E.D. in 4 days
50% S.E.D. 3 times = 150% S.E.D. in 3 days
65% S.E.D. 2 times = 130% S.E.D. in 2 days
100% S.E.D. 1 time = 100% S.E.D. in 1 day.

ERNST A. SCHMIDT, M.D.

FRACTURES

A New Device for Facilitating the Taking of Roentgenograms when Performing the Extra-articular Method of Internal Fixation in Fractures of the Femoral Neck. J. I. Sloat and Leonard T. Peterson. Jour. Bone and Joint Surg., **21,** 1041–1044, October, 1939.

This is a film tunnel with a cast aluminum back and polished bakelite face, so constructed as to fit on the pelvic support of a fracture table. It permits a cassette to be introduced and removed during operation without disturbing the sterile drapes. It also affords a broad support and can be removed before the application of a plaster cast.

JOHN B. MCANENY, M.D.

Fractures of the Carpal Navicular: Importance of Special Roentgenography. Abraham S. Rothberg. Jour. Bone and Joint Surg., **21,** 1020–1022, October, 1939.

Rothberg reports a case of fracture of the carpal navicular in which it was impossible to demonstrate the fracture until a roentgenogram was made with the hand in ulnar deviation whereby the navicular is seen in its greatest dimensions.

A second case showed a fracture of the carpal navicular which could not be demonstrated roentgenographically two months after the injury. Accordingly, two roentgenograms were made of the wrist, one with the tube directly over the wrist and the other with the tube shifted to one side. The shift of tube readily demonstrated the fracture line that was not easily seen in the routine view.

JOHN B. MCANENY, M.D.

Fractures in the Region of the Ankle Joint. Wellington D. Griesemer. Pennsylvania Med. Jour., **43,** 145–149, November, 1939.

Fractures of the ankle joint are briefly discussed. Anteroposterior and lateral x-ray views are advocated. Frequently an additional diagonal view will show a line fracture in mildly suspicious cases.

The author does not believe in delayed reduction, stating that all fractures should be manipulated immediately, and the normal relations in and about the joint exactly restored.

JOSEPH T. DANZER, M.D.

HEART AND VASCULAR SYSTEM

Tetralogy of Fallot: Correlation of Clinical, Roentgenologic, and Postmortem Findings. Joseph A. Pescatore, Joseph B. Wolffe, and Victor A. Digilio. Am. Heart Jour., **17,** 489–493, April, 1939.

At autopsy, the thoracic organs of a man, 20 years old, who had died of a complication of the tetralogy of Fallot, were placed under an x-ray tube in the same anatomic relationship which they had occupied in the body. Barium was forced into the superior vena cava. It was shown roentgenologically that the right auricle formed the right border of the heart and a goodly portion of its anterior surface, in this disease. Marked narrowing of the pulmonary artery was evident. The right ventricle occupied most of the anterior surface of the heart, only a small portion of the left ventricle being seen. The apex was formed completely by the right ventricle. The left auricle occupied a position posterior and somewhat medial to the right auricle. The left ventricle was very small.

W. H. GILLENTINE, M.D.

The Value of Special Radiologic Procedures in Detecting Cardiac Enlargement in Children with Rheumatic Heart Disease. Ann G. Kuttner and Gertrude Reyersbach. Am. Heart Jour., **18,** 213–227, August, 1939.

The authors attempted to determine radiologically evidence of early rheumatic heart disease in children. The chief value of any radiologic procedure in cases of early rheumatic heart disease is to detect changes in the size or contour of the heart in the same patient at different times. The measurement of the "angle of clearance," of Wilson; that is, the degree of rotation necessary to separate the left lower cardiac border from the vertebral column in the left anterior oblique position (normal less than 55 degrees); was an aid in ruling out left ventricular enlargement in patients with high diaphragms and transverse hearts, in whom the heart appears to be enlarged to the left in the anteroposterior position. Early enlargement of the left auricle could best be demonstrated by the backward displacement of

the barium-filled esophagus. The absence of displacement did not exclude the possibility of an enlarged left auricle.

These workers confirmed the work of previous investigators who found the measurement of frontal area of little value in establishing a definite abnormality in this group of cases. One hundred and one children were used as controls in this study and 55 children in the rheumatic group.

W. H. GILLENTINE, M.D.

Acute Mesenteric Arterial Thrombosis. Warner Ogden. Minnesota Med., **22,** 525–527, August, 1939.

This condition was first reported by Hodgson, at Guy's Hospital, in London, in 1915, and again three years later by Chaussier.

Since 1923, three cases have been encountered at Johns Hopkins Hospital; in 300,000 admissions at the Charity Hospital, in New Orleans, only 13 cases; in 30,000 admissions at the Emergency Hospital, Washington, D. C., seven cases; at the Boston City Hospital, in 33 years, 51 cases; at the Miller Hospital, St. Paul, in 61,000 admissions, five cases, three of which were secondary to operations.

Etiologic factors may be: arteriosclerosis, a preceding operation, trauma to the abdomen, distention of the gut, or great straining on exertion.

In 90 per cent of the cases the thrombosis occurs in the superior mesenteric vessels, 61 per cent being in the artery.

Differential diagnosis includes all causes of acute abdominal pain.

The operative treatment and prognosis are discussed. The mortality is from 85 to 100 per cent.

PERCY J. DELANO, M.D.

Cardiac Aneurysm. Louis H. Berk. Am. Heart Jour., **17,** 569–580, May, 1939.

The author mentions Hall's report, in 1903, of 112 cases of cardiac aneurysm and refers to Sternberg's authoritative monograph written in 1914. This writer adds 16 cases diagnosed by clinical and radiologic examinations at Bellevue Hospital.

This condition follows coronary thrombosis (9 per cent of cases) and is the mechanical result of stretching of the fibrous transformation of the myocardium. A diffuse eccentric dilatation of the cardiac apex has been described and also the type presenting a circumscribed bulge.

Clinical findings are suggestive. Roentgenograms made in the anteroposterior and oblique positions, together with the fluoroscopic examinations, will show the abnormal contour of all parts of the anatomic divisions of the heart. The degree of pulsation of the mass is directly proportional to the size of the aneurysm and it varies inversely with the amount of pericardial thickening and the presence of adhesions. Hypertrophic muscle at the border of the aneurysm may be mistaken for aneurysm because of its marked pulsation. Roentgenographic visualization is impossible if the aneurysm develops on the diaphragmatic or posterior surface of the heart. The presence of pleuropericardial adhesions with immobilization of the apex, which may be seen on the fluoroscopic screen, is an indirect corroborative sign of cardiac aneurysm. Measurement of the bisector of the left ventricle may, in the absence of concomitant hypertension, demonstrate occult bulging of the left ventricular border.

W. H. GILLENTINE, M.D.

The Vascular Complications of Cervical Ribs and First Thoracic Rib Abnormalities. Kenneth C. Eden. British Jour. Surg., **27,** 111–139, July, 1939.

This is a complete paper discussing the syndrome of vascular disease of the arm produced by the irritation of the subclavian artery in the neck by a cervical rib or the first thoracic rib. Three of the author's cases are reported, and there is a review of the literature with tabulation of 45 cases dating as far back as 1861.

The roentgenograph of the first case showed large complete bilateral cervical ribs passing from the transverse process of the seventh cervical vertebra on each side to the corresponding first thoracic ribs. On the left side there was a large splayed-out end to the rib where it articulated with the first thoracic rib.

Operation revealed a fusiform dilatation of the third part of the subclavian artery lying partly on the splayed-out end of the cervical rib and partly in a groove in the first thoracic rib and was pushed forward considerably. Following the removal of the bony prominence at the lower end of the cervical rib, the patient was symptomatically cured, although the aneurysm was still present. In this case there was no involvement of the brachial plexus, but symptoms were due entirely to obstruction of some of the smaller vessels to the fingers, giving rise to disease of the digital vessels and their spasmodic closure on exposure to cold.

The second case showed a visible pulsating swelling above the middle of the left clavicle and there were no sensory, motor, or trophic changes in the hands and no evidence of vascular changes. The roentgenograph showed bilateral complete cervical ribs articulating with short bony processes on the first thoracic ribs. An aneurysm of the subclavian artery was found, at operation, and the lower end of the cervical rib was removed. Subsequent to operation severe vascular disease of the arm, attributed to thrombosis of the arteries of the arm right up to the aneurysm, developed.

The third case presented severe vascular disease involving the thumb, index, and middle fingers of one hand, and, eventually, the entire hand as far as the wrist. The roentgenograph of the neck and thorax showed no cervical ribs or any abnormality of the thoracic ribs. Operation revealed slight dilatation of the subclavian artery due to intermittent pressure between an abnormally low clavicle and first thoracic rib. After removal of a portion of the first thoracic rib, there was rapid relief of symptoms.

The number of recorded cases of vascular complications as compared with the volume of literature on the

nervous complications reveals the relative incidence of the two conditions. In the majority of the reported cases, the first complaint was pain in the arm or vascular disturbance in the fingers, and, in a few, there was a pulsatile swelling in the neck. Two main types of cases may be distinguished. In the one there is a massive blockage of the main vessels of the forearm or arm, with severe pain and weakness of the arm but with collateral circulation adequate to preserve the nutrition of the fingers. In the other type the small vessels of the fingers and the hand become progressively blocked, leading to Raynaud attacks in the fingers or finally to gangrene of the fingers. In the majority of cases a cervical rib was present, and it was nearly always found to be of the complete type articulating with the first thoracic rib by an enlarged extremity, often by means of a diarthrodial joint.

The evidence in most of the cases reported supports the hypothesis that vascular disease of the arm is due to damage to the wall of the subclavian artery by intermittent compression between the clavicle and cervical rib or first thoracic rib, resulting in dilatation of the artery with dense fibrosis around it and thrombosis in the intima. With continued trauma, emboli lodge in the vessels of the hand and arm, giving rise to progressive thrombosis and symptoms of vascular disease.

MAX CLIMAN, M.D.

The Normal Heart Volume in Man. G. Liljestrand, E. Lysholm, G. Nylin, and C. G. Zachrisson. Am. Heart Jour., **17,** 406–415, April, 1939.

The authors, by means of a specially constructed machine, have taken simultaneous roentgenographic projections at right-angles and have determined values for the volume of the heart in 101 healthy men, between the ages of 21 and 47 years. By a slight modification of the Rohrer-Kahlstorf formula, the writers obtained results approximately 6 per cent higher than the values presented by these two men. The writers have found that the normal heart volume varies between 7 and 13 c.c. per kg. of body weight and between 250 and 490 c.c. per square meter of body surface.

W. H. GILLENTINE, M.D.

Body Build and Heart Size: A Study of 20 Pairs of Identical Twins and 15 Pairs of Unrelated Individuals with Similar Body Height and Weight. Wilfrid J. Comeau and Paul D. White. Am. Heart Jour., **17,** 616–623, May, 1939.

Roesler, in his text on cardiovascular roentgenology, states that body weight and body surface area give the greatest degree of correlation with heart size in individuals of varying body measurements. The authors of this article present data on the heart size of individuals of similar body builds, namely, 20 pairs of identical twins and 15 pairs of unrelated individuals. Their data show a close correspondence of heart size in the identical twins. In the pairs of unrelated individuals, the similarity in heart measurements is close, considering the constitutional and racial differences in body structure which are not covered by simple height and weight measurements.

W. H. GILLENTINE, M.D.

THE HIP JOINT

Adolescent Deformities of the Acetabulum: An Investigation into the Nature of Protrusio Acetabuli. John Gilmour. British Jour. Surg., **26,** 670–699, April, 1939.

Cases of protrusion are divided into two categories: (1) A primary group the origin of which has been the subject of much speculation, and (2) a secondary group which results from destructive diseases of the hip joint or from injury of the acetabular floor. The first recorded case dates back to 1824. An analysis of 37 cases from the literature up to 1929, revealed that the deformity was more common in females in the proportion of 30 to 7. Bilateral and unilateral protrusions were almost equal in numbers (17 to 20). Osteoarthritis was the most frequent complication (in 20 out of 26 cases). There was a history of possible joint infection in a third of the cases. The author reports eight of his own cases of primary protrusion, six of which were bilateral and two unilateral. All of these patients presented characteristic clinical findings of varying degrees of fixation of the hip, tilting forward of the pelvis, and hyperlordosis of the lumbar spine. In the females a history was usually obtained of onset of symptoms during adolescence. Two cases of deep acetabula are reported, both of which showed osteo-arthritic changes. Three cases of secondary protrusion are reported following acute arthritis, acetabular fracture, and tuberculosis of the hip, respectively.

The features of secondary protrusion are: (*A*) irregular enlargement of acetabular floor toward the pelvis, resulting in protrusion; (*B*) Shenton's line is interrupted; (*C*) some destruction of the head in inflammatory cases, and (*D*) the affected limb is shortened.

A method of pelvimetry is described which was used in all the cases. There are three characteristics which distinguish the pelvimetry of cases with protrusion: the intercristal diameter is apt to be increased; the bitrochanteric diameter is relatively reduced, and the intertuberous diameter is always less than normal.

The diagnosis of acetabular deformities depends on roentgenologic examination. The entire pelvis must be roentgenographed with the rays projected vertically through the mid-line of the pelvis. The "tear drop figure" of Köhler, which forms the normal pattern of lines characterizing the normal hip joint, is used as a basis for recognition of the abnormal acetabulum. Various distortions of this pattern are found in acetabular deformities.

The clinical aspects of 44 cases of primary acetabular deformities are recorded. There were nine cases without arthritic changes and the signs of deformity were limitation of hip movement, pelvic tilt, lumbar hyperlordosis, and a peculiar waddling gait. There were 19 cases of unilateral arthritic changes with progressive

stiffness and pain in one hip, and 16 cases with bilateral arthritic changes.

Various theories of the etiology of this condition are mentioned, notably osteochondritis and adolescent developmental changes.

Treatment is required for marked limitation of hip movement and the onset of secondary postural deformities. Non-operative treatment in the form of forcible stretching under anesthesia, or weight extension on an abduction frame, will usually suffice to overcome the contractures around the hip.

Operative treatment is indicated when hip movement is limited by contact of femoral neck with acetabular margin and when palliative measures fail to relieve moderate degrees of protrusion with painful osteoarthritic changes.

MAX CLIMAN, M.D.

INFECTION

X-ray Treatment of Infections: A Review of the Literature and Report of Cases of Mastoiditis and Sinusitis. B. R. Dysart. Ann. Otol., Rhinol., and Laryngol., **48,** 433–442, June, 1939.

A brief review of some of the literature on roentgen therapy of infections, particularly mastoiditis and sinusitis, is given. The author describes his experience with this method of treatment, and includes short summaries of 12 cases. Small doses of roentgen rays were employed; from 50 to 60 r in the acute cases and up to 100 r in the more chronic infections. In 12 cases of acute mastoiditis, seen during one year, all resolved without operation, from one to four doses of roentgen rays being given at intervals of five days. Several cases showing roentgenologic evidence of necrosis were not treated by radiation. The author's results were not as uniformly satisfactory in the treatment of sinusitis as in otitis media and mastoiditis.

LESTER W. PAUL, M.D.

The Radiological Manifestations in Bilharziasis. Ragheb. British Jour. Radiol., **12,** 21–27, January, 1939.

In infested countries, a high percentage of the population is afflicted with bilharzia. The mode of infection is through an abrasion in the skin. All organs of the body are affected, although the genito-urinary and gastro-intestinal tracts are most commonly and most severely involved. The clinical diagnosis is readily made, the cardinal symptom being bleeding from the urinary or gastro-intestinal tract. The diagnosis is readily established by the identification of the ova in the excreta. The ova become deposited in the submucosa, giving rise to ulceration and subsequent calcification, which can be revealed roentgenographically. Two forms of reaction to infestation are observed: (1) ulceration and deposition of calcium following lodgment of the ova in the mucosa; (2) the formation of papillomas, with subsequent ulceration and calcification, with appearances similar to stones.

The first form is predominant in the bladder, ureters, and seminal vesicles. The second form is found commonly in the intestines and kidneys. Papillomas in the intestinal tract are not usually calcified, except in the region of the appendix. Those occurring in the kidneys are usually calcified, causing shadows which resemble stones. The calcifications in the urinary tract are fixed in position and do not increase in size even in the course of years. They do not encroach on the lumen as they are embedded in the mucosa. The calcified papillomas are readily seen roentgenographically, the uncalcified ones by the aid of opaque media. The bladder is usually the first organ to show evidence of the disease. A number of excellent illustrations are given in this article, showing various appearances of different stages and locations of the disease.

S. J. HAWLEY, M.D.

The Treatment of Severe Carbuncles by X-ray. Frederick W. O'Brien. New England Jour. Med., **220,** 917–919, June 1, 1939.

O'Brien reviews the pertinent literature on irradiation of infectious processes and the *modus operandi*.

A series of 130 cases, from 1934 to 1937, inclusive, of severe carbuncle are presented herein. All these patients were sick enough to be hospitalized and among the complications were thyrotoxicosis, psychosis, varicose ulcer, compression fracture subdural hematoma, mid-thigh amputation, carcinoma of the larynx, and cardiac decompensation. The male patients numbered 95, the women 35; 126 were discharged well; four died (3 per cent).

Cases are grouped according to the treatment received. Group I, consisting of 60 patients, received irradiation only. In this Group there were nine diabetics (one died), one death, and the hospital stay averaged eight and one-half days. Group II, composed of 34 cases, received irradiation and then surgery. There were four diabetics (one died), one death, and the hospitalization averaged 13 days. Group III, totalling 36 cases, received surgery followed by irradiation. There were three diabetics (one died), two deaths, and an average of 21 days hospitalization.

The treatment described is three treatments with medium or high voltage irradiation.

The result of the treatment was early relief of pain; if early in the process, absorption of the exudate, and, if late, rapid suppuration and arrest of spread.

J. B. MCANENY, M.D.

THE INTESTINES

Enteric Intussusception Due to Invagination of Meckel's Diverticulum. Milroy Paul. British Med. Jour., **1,** 504, March 11, 1939.

The author describes a case of intussusception due to invagination of the ileum through the base of a Meckel's diverticulum. In this case, as is usual in cases of intussusception in the ileum, the diverticulum travelled ahead and was found at the base of the invaginated gut.

Analysis of the literature shows that Meckel's diverticulum occurs in 1.3 per cent of all cases and is a fac-

tor in 2.5 per cent of all cases of intussusception. The author feels that this last figure is too high. Of the Meckel's diverticula which require surgery, 17 per cent do so because of intussusception.

This case should be of interest to radiologists as an unusual type of intestinal obstruction.

Q. B. CORAY, M.D.

The Importance of the Roentgen Examination in the Diagnosis of Regional Ileitis: Report of a Case. Joseph C. Root. Cleveland Clin. Quart., **6,** 146–152, April, 1939.

This condition usually occurs in young adult male patients who most often complain of diarrhea and abdominal pain. The diagnosis is quite difficult without a roentgen examination, which usually shows narrowing of the small intestinal lumen, or the so-called "string-sign," resulting in a degree of obstruction with dilatation of the proximal bowel. There is alteration of the mucosal pattern in the involved segment of bowel. If the terminal ileum cannot be demonstrated by barium enema, barium by mouth followed by serial films and fluoroscopy will result in a diagnosis.

J. B. MCANENY, M.D.

Two Cases of Non-rotation of the Mid-gut Loop in Children. P. L. Hipsley. Australian and New Zealand Jour. Surg., **9,** 79–84, July, 1939.

The first case, that of a girl nine and one-half years of age, suffered from recurrent attacks of vomiting. Pre-operative x-ray studies revealed a large obstructed duodenum and the associated finding was a completely left-sided colon with the cecum pointing upward to the left upper quadrant. At operation, the condition was shown to be due to congenital failure of rotation of the mid-gut segment (the segment of bowel between the duodenum and the transverse colon), with associated short mesentery, right-sided small bowel, and left-sided colon. The duodenal obstruction was due to adhesions near the ligament of Treitz. Spontaneous relief followed surgical repair.

The second case was a seven-year-old boy who also had a history of recurrent attacks of abdominal pain and vomiting. X-ray examination revealed a similar picture in the colon; it was left-sided and the cecum pointed upward; the small bowel was on the right side. At operation, the same failure of rotation of the mid-gut loop was found. The duodenum in this instance was not bound down. The patient developed an acute obstruction three weeks post-operatively and expired.

SIMON POLLACK, M.D.

The Roentgenogram in Intestinal Obstruction: Its Value and its Limitations. P. E. Wigby and W. H. Cochran. Texas St. Jour. Med., **34,** 740–745, March, 1939.

The authors discuss, in a comprehensive fashion, the value and limitation of the plain roentgenogram in the diagnosis of intestinal obstruction. The experimental work on animals is reviewed and the underlying physiology and pathology emphasized.

A film taken in the supine position is preferred, since it best shows the general pattern and continuity of the intestinal coils. If evidence of obstruction is found, a second roentgenogram is made in the erect position to show fluid levels.

Distention, with gas in a portion of intestine where there should be no gas or not as much as is shown by x-ray examination, and fluid levels due to accumulated fluid are the characteristic findings. A study of the intestinal pattern, site of distention, and correlation with physical findings aid in diagnosing the site of obstruction and often the type of obstruction.

Gas shadows and even distention may be seen without obstruction, in children below the age of three years, following vigorous catharsis, morphine deprivation, and paralytic ileus. Conversely, in cases of obstruction, the characteristic x-ray findings may and probably will be absent if the radiograph is made before four to six hours after the onset. This is especially true in cases of partial, intermittent obstruction, and in very high obstruction in cases in which the length of involved intestine is short and the distention is readily relieved by vomiting.

JOHN M. MILES, M.D.

THE KIDNEYS

Excretory Pyelography in Infants, with the Help of a Tomograph. J. Jochims. Röntgenpraxis, **11,** 371–373, June, 1939.

Intravenous pyelograms in infants are quite often unsuccessful, due to too large an amount of gas in the stomach and intestines. Often all means fail to remedy this difficulty. Tomography is a method of demonstrating kidneys which might be completely obscured by gas on the regular films. The level of the kidneys is considerably posterior to that of the stomach and intestines, and it is possible to get satisfactory laminagrams of them. The layer chosen for tomography is two and one-half to three centimeters anterior to the surface of the back. The stomach and intestines are made practically invisible by this method. A satisfactory demonstration of the kidney pelves and calices can be achieved.

HANS W. HEFKE, M.D.

Hydronephrosis Resulting from Ureteropelvic Obstruction. L. E. Pierson and E. M. Honke. Jour. Iowa St. Med. Soc., **29,** 491–494, October, 1939.

This discussion is limited to those lesions, especially anomalous renal blood vessels, which produce a partial obstruction at the junction of the kidney pelvis and ureter and which, if allowed an unrestricted development, will eventually destroy the entire kidney. Studies of hydronephrosis have demonstrated that anomalous vessels constitute one of the most common, single, etiologic factors. In the authors' 12 cases, the average age was found to be 32 years, with 75 per cent occurring in males. Symptoms due to hydronephrosis alone

are not characteristic, especially in cases in which the obstruction has developed gradually. The most frequent symptoms are pain in the back, nausea, and vomiting. Diagnosis is established by pyelographic studies. If the obstruction is not complete, the renal pelvis will be found dilated. A characteristic sickle-shaped curvature of the ureter is often seen immediately below the ureteropelvic junction. This represents the actual impingement of the vessel on the ureter and is pathognomonic. The most common complications are infection and calculus formation.

If no renal function is evident, nephrectomy is indicated. If the kidney function is only partially destroyed, some type of plastic operation should be considered. Ligation of the anomalous vessels is not recommended since they are usually end arteries and ligation will often produce renal atrophy or cortical necrosis.

LESTER W. PAUL, M.D.

Neoplasm of Horseshoe Kidney. Archie Aspinall. Australian and New Zealand Jour. Surg., **8,** 408–412, April, 1939.

The author presents a report on a male patient, 26 years of age, who complained of attacks of alternating constipation and diarrhea associated with colicky pains in the lower abdomen. Mucus was present in the stools, but no blood. The urine was sp. gr. 1.030 and contained no blood or albumen. A rounded, fixed mass was palpated just below the umbilicus in the midline. Barium meal and enema revealed no lesion of the gastro-intestinal tract. Cystoscopic examination showed good function of both ureters; no pyelograms were made pre-operatively.

At operation, the tumor was found to be retroperitoneal and in the lower pole of a horseshoe kidney. It appeared soft and encapsulated, but proved, on microscopic study, to be a papillary carcinoma of renal origin. The patient has been in good health for one year after the resection of the tumor and follow-up pyelograms have revealed the persistence of the renal horseshoe deformity and ptosis of the right kidney.

SIMON POLLACK, M.D.

A Case of Adenosarcoma of the Kidney (Wilms' Mixed Tumor). J. Agerholm-Christensen. Acta Radiol., **20,** 69–74, February, 1939.

A bilateral adenosarcoma of the kidney (Wilms' mixed tumor) in an eight-month-old child is described. Metastases were present in liver and lungs. The patient died two months after admission to the hospital and the institution of x-ray treatment. Due to the insidious onset and development of the disease, early diagnosis is rare. The importance of pyelography for the early recognition of these tumors is emphasized.

ERNST A. SCHMIDT, M.D.

Wilms' Tumor (Adenomyosarcoma) of the Kidney in Children: Report of a Case. C. C. Higgins and F. L. Shively, Jr. Cleveland Clin. Quart., **6,** 265–274, October, 1939.

Higgins and Shively present an historic review of Wilms' tumor and discuss the various theories as to its origin. They subscribe to Ewing's theory that it arises from the renal blastoma, thereby accounting for the adult type of tissue found in it.

A complete case report is presented and the various features discussed. As a rule the abdominal tumor is first discovered by the mother; urinary symptoms are secondary. Usually these growths decrease greatly in size with irradiation, which facilitates surgical removal. Post-operative irradiation should be given.

JOHN B. MCANENY, M.D.

Tumors of the Renal Pelvis: Report of a Case. F. C. Schlumberger. Cleveland Clin. Quart., **6,** 153–160, April, 1939.

This is a complete case report of a patient complaining of hematuria, in whom a filling defect in the renal pelvis led to a diagnosis of tumor of the kidney pelvis. Repeating the pyelogram again showed the same defect. Diagnosis was confirmed at operation.

Only 13 tumors of the renal pelvis have been found at the Cleveland Clinic, in a series of 341 renal tumors. Treatment is operative, although irradiation holds some promise. Most of the tumors are epithelial in origin. The prognosis is not good.

J. B. MCANENY, M.D.

The "Position-relief Syndrome" of Hydronephrosis. John M. Berkman and James T. Priestley. Minnesota Med., **22,** 217–222, April, 1939.

The authors call attention to the present-day tendency to forget the clinical approach to the patient. The young physician is too apt to think in terms of laboratory results.

Urologic symptoms have a certain constancy. Hydronephrosis is characterized often by a dull and aching pain situated anteriorly in the upper part of the abdomen on the side of the involved kidney. It is usually not referred to the lumbar region or down to the testes. It may be constant for several days, but is usually present for a few hours or a day or two at a time and disappears only to return at a later date.

Walking and standing aggravate the pain. Patients often awake in the morning free from the pain. Relief is obtained by reclining. Many get relief by lying on the unaffected side with a pillow under the lumbar region.

There is a frequent associated loss of appetite and nausea.

Treatment is primarily surgical in these cases. Commonly there is incomplete drainage from the renal pelvis which is caused by abnormal insertion of the ureter into the pelvis, narrowing of the lumen of the ureteropelvic juncture by fibrosis and thickening of the tissues in this region, compression of the ureter by anomalous vessels or fibrous bands, or possibly, physiologic abnormalities in the neuromuscular mechanisms

which normally effect complete emptying of the renal pelvis.

A series of cases illustrating the value of the "position-relief syndrome" in diagnosis of hydronephrosis is reviewed. In some instances the patients were able to abort attacks by lying down at the onset. Intravenous urography was sufficient to show the dilatation of the pelvis in most of the cases cited, and the urinalysis and flat plate of the kidney region revealed nothing abnormal. Anorexia and nausea were common incidental symptoms. In all cases the prominence of the "position-relief syndrome" pointed the way to the correct diagnosis.

PERCY J DELANO, M.D.

THE KNEE JOINT

Common Injuries Involving the Knee Joint. Louis H. Edmunds. Northwest Med., **38,** 85–91, March, 1939.

The author points out that even though roentgenograms are usually negative in these common knee injuries, they should be made because of their negative value, and to rule out associated fractures and joint mice, which cannot always be ruled out otherwise.

ANTONIO MAYORAL, M.D.

Improved X-ray Technic in Studying Knee Joints. Edward C. Holmblad. Southern Med. Jour., **32,** 240–243, March, 1939.

The author lists the advantages of the two oblique views and of the postero-anterior view of the knee, the latter visualizing the intercondylar notch of the femur. Clear and simple methods for obtaining these views are described, with illustrations.

JOHN M. MILES, M.D.

KYMOGRAPHY

Roentgen Kymographic Studies of Myocardial Infarction. Richard Gubner and J. Hamilton Crawford. Am. Heart Jour., **18,** 8–24, July, 1939.

The authors used the roentgen kymograph in an attempt to localize and determine the extent of the infarct in 45 patients with coronary thrombosis by noting changes in the contractility of the heart as revealed in the movement phenomena. Exposures were taken in the postero-anterior and in the slight and full left oblique positions (about 25° and about 60 to 70°), showing a record of the contraction of the anterolateral wall, of a large part of the posterior wall of the left ventricle, and of the right ventricle in addition.

Normal movement was defined as follows: the aortic and pulmonic arterial waves should be identical with the carotid sphygmogram; the right auricular waves should be multiple and correspond to waves of the jugular pulse; the ventricular waves should resemble ventricular volume curves providing that a correction is made for magnification in the kymogram and for the oblique position of the left heart border and provided cognizance is taken of the elevation of the apex and positional changes of the heart, as a whole, in its cycle.

Cardiac decompensation causes a diminution or loss of the normal upward apical stress. Reverse pulsations may occur at the apex of the heart when the heart is greatly dilated. Caution is to be used in interpreting diminution or absence of pulsations in the region as indicative of infarction. Coronary thrombosis and constrictive pericarditis are the only two conditions completely inhibiting contraction of the left ventricle. Radiologic diagnosis of coronary disease is confirmed electrocardiographically in 75 per cent of cases. The kymogram may indicate a more extensive involvement than is shown by the electrocardiogram; for instance, indicating involvement of both anterior and posterior walls while the electrocardiogram suggests infarction of one or the other. It may be an aid in cases in which bundle-branch block prevents a typical electrocardiographic picture of infarction. In general, posterior wall infarctions are visualized with difficulty.

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